SCIENTIFIC AMERICAN SUPPLEMENT. No. 1163

Scientific American, established 1845.
Scientific American Supplement, Vol. XLV. No. 1163.

NEW YORK, APRIL 16, 1898.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

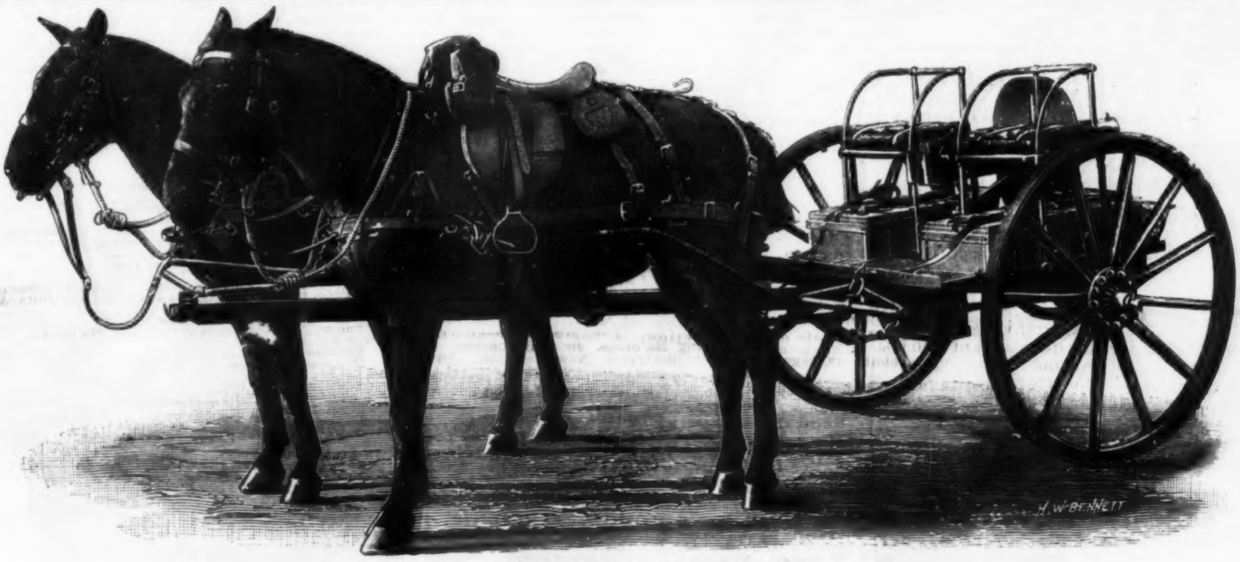


FIG. 1.—CAVALRY CARRIAGE.

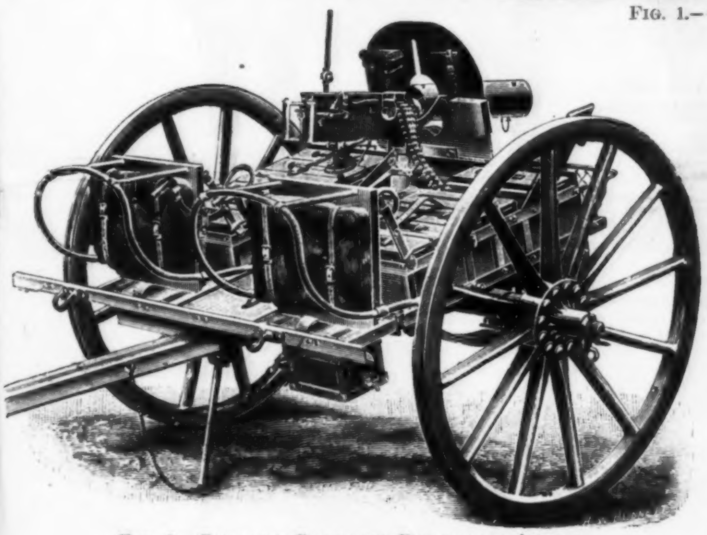


FIG. 2.—CAVALRY CARRIAGE READY FOR ACTION.

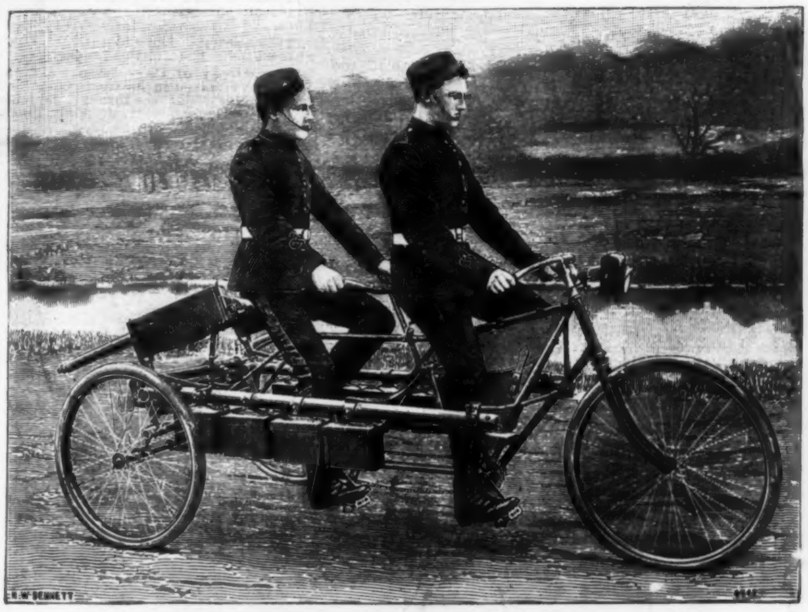


FIG. 4.—EXTRA-LIGHT RIFLE MOUNTED ON TRICYCLE.

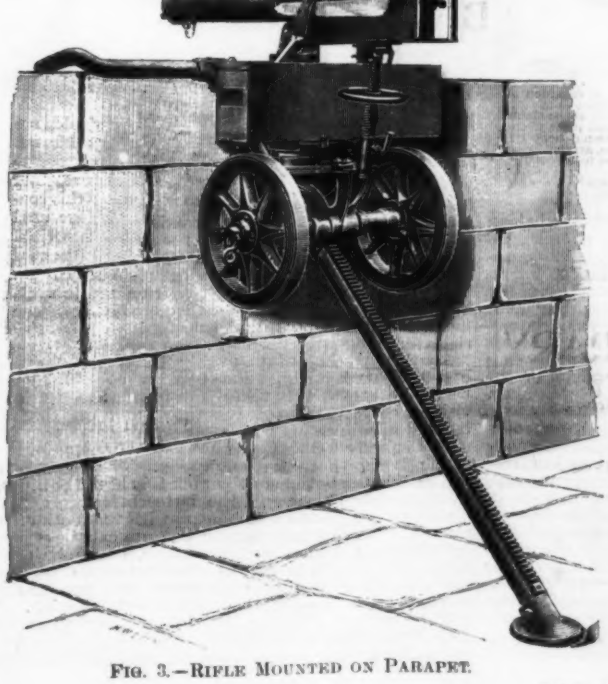


FIG. 3.—RIFLE MOUNTED ON PARAPET.

FIG. 5.—RIFLE TRICYCLE IN ACTION.

THE MAXIM RIFLE-CALIBER GUN.

THE MAXIM GUN.

The Maxim gun, as is well known, is entirely automatic, and will continue firing so long as the firing button remains pressed forward. Single shots can be fired by releasing the button immediately after a discharge. In that case the gun will be loaded and firing can be continued by again pressing the firing button. To commence firing with a new belt of cartridges, it is necessary to turn the crank handle until it touches the buffer spring. This draws the lock back and allows the carrier to drop into its lowest position. The end of the cartridge belt is then inserted through the feed block from the right and pulled through to the left as far as it will go and the crank handle released, when it will be carried back, thus throwing forward the lock; the carrier now rises and seizes the base of the cartridge in the feed block. The crank handle is again turned forward and the lock goes back, the carrier pulling the cartridge out of its belt and afterward placing it in a line with the barrel. The belt is then pulled again to the left as far as it will go and the second cartridge comes into place over the chamber of the barrel. On letting go the handle once more, the lock goes forward, inserts the cartridge in the barrel, and the carrier, in rising, seizes the base of the next cartridge in the belt. The gun is then ready to commence firing.

We have on previous occasions commented on the remarkable performances of the Maxim gun, which will discharge from a single barrel from 600 to 700 rounds per minute.

An interesting development of the rifle-caliber gun is that known as the "extra-light." Of this we publish several illustrations. Fig. 9 shows the gun in firing position mounted on a tripod; Fig. 7 as packed and carried by infantry; Fig. 8 illustrates the manner in which it is carried in a cavalry boot; Fig. 4 shows the extra light gun mounted on a tricycle; while Fig. 5 gives a view of the same gun being fired. All these views have been prepared from photographs taken from the gun itself.

The extra-light gun is not intended to take the place of the standard rifle-caliber guns just described, as certain desirable features have to be sacrificed in order to save weight. It has, however, the advantage that it can be transported to positions that might not be attainable by the standard gun within the space of time that would be available under certain conditions of warfare that might easily occur. It would be useful to stop a cavalry charge in an emergency, to check the sudden rush of a savage horde, or perhaps to cover a retreat; but it is not well adapted for an attack on a position, and is, in fact, a weapon of defense which might prove of incalculable value, but is not to be relied on in the same way as the standard gun. It would be also useful for police work in new countries, and, in fact, wherever a small disciplined force had to deal with much larger numbers of undrilled men who would become demoralized if their first rush were stopped. It is deficient in comparison with the standard gun, inasmuch as having, in its lightest phase, no water jacket, it cannot be fired continuously for an indefinite number of rounds, as the barrel would naturally get too hot and it would be necessary to allow it time to cool. Although the mechanism is, in its general features, practically identical with that of the standard gun, there are one or two trifling exceptions; for instance, the spring for absorbing a portion of the recoil energy, and for returning the recoiling parts to their firing position after each discharge, is placed within the casing in place of being outside. This change is made in order to get the gun into a narrow leather case. This gun, however, is now occasionally made with a small water jacket, by means of which the number of rounds that may be continuously fired is increased; but, as already stated, the standard gun with its full supply of water is always preferable when it can be transported, and it may be said that for regular operations of warfare the standard weapon is itself sufficiently light to enable it to be, as a rule, transported as rapidly as any considerable body of troops can be moved. The question of ammunition has also to be taken into consideration, and it is little use having a very rapid-firing gun unless it can be kept supplied with ammunition; excepting, as already stated, for purposes of dealing with a sudden rush.

Referring to Fig. 9, the tripod mounting is made of thin tubular steel, the hind leg or trail being hinged midway of its length, so that it can be folded for transport. The front legs are provided with projecting legs at their upper ends, and these bear against the upper part of the tripod. The front legs can be housed along the hind leg. The gun is supported by a crosshead pivoted to the upper part of the tripod. The crosshead is provided with an arm which has its bearing on an arc or segmental piece fixed to the hind leg of the tripod, as shown, and which carries the elevating gear. This arm can be clamped to the arc in any desired position by means of an eccentric clamp. The transverse movement of the gun is limited by two spring catches mounted on the ends of the arc. The weight of the gun is 27 pounds and that of the tripod 17½ pounds. Referring to Fig. 7, the weights additional to those of the gun and tripod are 1 pound 14 ounces for spare parts and 11 pounds 2 ounces for the knapsack. This would make a total weight of 57½ pounds, or just over ½ cwt. Another man would carry the ammunition in much the same manner. Five hundred rounds of 0·303 smokeless ammunition would weigh just 44 pounds, while the knapsack would weigh 4 pounds.

The cavalry gun and tripod is the same as the infantry gun and tripod, but is packed differently. Our illustration, Fig. 8, shows the off side with the gun itself in its case on boot. The tripod is carried on the near side in another case, and is naturally not shown in the engraving. The weight of the boot of the gun is 6 pounds, and that of the tripod boot 8 pounds.

The tricycle gun is a very interesting feature, but it is needless to say that it would only be available in districts where there were fairly good roads, and this discounts at once the great advantage this nature of weapon possesses in being transported with ease over difficult country. It may be, however, that the improvement in the motor car, for which we are still waiting, will some day enable guns of various natures to be transported with greater facility; but in that case an "extra-light" gun would be likely to have its sphere of usefulness curtailed instead of extended, for the saving in weight gained with the extra-light weapon would not be so important a factor if mechanical means were utilized for transport. As seen by Fig. 5, two guns are mounted on the tricycle. The weight of the cycle is 121 pounds, that of the two guns 54 pounds, of the tripod 17½ pounds, and of the spare parts 8 pounds. A thousand rounds of ammunition carried in the boxes would weigh 87½ pounds. This is in all a good weight to propel, but we have seen the two riders drive the machine at a very smart pace on the level. Hill work would naturally be done on foot, the tricycle becoming a hand carriage.

In Figs. 10, 11 and 12 is shown a complete mule equipment for a rifle-caliber gun. Fig. 11 illustrates the gun with the combined field carriage and tripod on their pack saddle. Another mule carries the wheels, as shown in Fig. 10, while a third mule carries the ammunition. The load for one animal is 2,000 rounds; and, of course, the number of rounds that accompany a gun is dictated by strategical or tactical considerations.

The mule service is, naturally, for mountain warfare, but the end of the pole or back leg of the tripod can be hooked on to a limber, and thus form an infantry carriage for horse traction.

Another method of mounting the gun is shown in Fig. 3. This is an ingenious parapet mounting, which would be exceedingly useful for fortifications or provisional entrenchments. It is shown on a wall, but can be used in connection with sandbags or earth embankments equally well. There are two claws, one only of which is shown in the engraving. These grasp the wall, while the bottom of the rack is held to the ground by the weight of the gun, the latter being worked up by means of a pinion which gears with the teeth of the rack. When in firing position the gun can be secured by a locking device, and, of course, it can be easily lowered when not in use, so as to act as a disappearing gun. The facility with which the gun can be transported is an admirable feature in this design. As will be seen, there is a pair of wheels, and when the gun is run down to the bottom of the rack the wheels are on the ground, and support the whole weight. The

Fig. 7.—Extra-light Rifle in Case for Infantry.

Fig. 8.—Extra light Rifle Packed in Cavalry Boot.

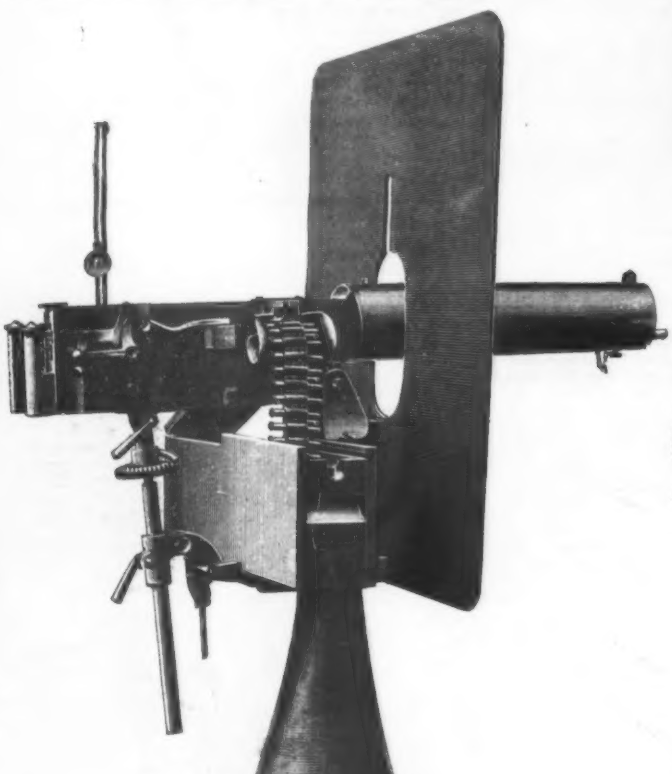


Fig. 6.—Maxim Gun for Naval Service.

Fig. 9.—Extra-light Rifle-caliber Gun.

THE MAXIM RIFLE-CALIBER GUN.

carriage is then locked to the rack by a suitable device, the rack becomes a pole, and the securing arms are handles, between which a man can stand and push the gun in front of him. Military authorities attach considerable value to ready means of changing gun positions.

The standard R. C. gun is also intended to be used to accompany cavalry, and really becomes very light horse artillery of a very effective character. In Fig. 1 is shown what is known as the galloping carriage with gun and ammunition boxes. Here, again, the gun is almost hidden, not only by the shield, but by the seats of the carriage. The breech end is, however, shown projecting from between the seats. This, of course, is the traveling position, but in Fig 2 the galloping carriage is shown in the firing position. The seats are turned over and form shields, being plated with steel for the purpose. The belt of cartridges is also here seen emerging from one of the ammunition boxes and passing into the gun. Twelve boxes of cartridges are

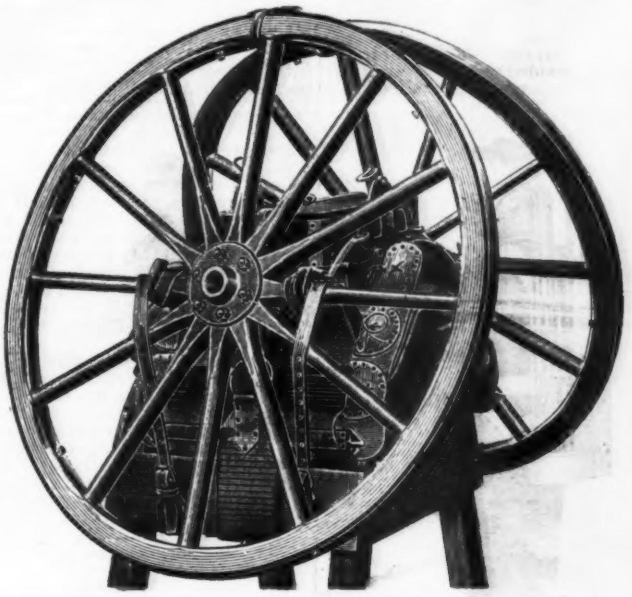


FIG. 10.—MULE EQUIPMENT.

carried on this carriage, the total number of rounds being 3,000. This galloping carriage is quite a new feature, but several have already been supplied for abroad. The carriage has been pretty severely tested by the military authorities, in being taken at galloping pace over ditches, banks, etc., and it is considered that it would be able to go anywhere that cavalry would be able to act.

Turning to the naval service, we find various mountings for the R. C. Maxim gun. In Fig. 6 is shown a cone mounting which is much used, it being adapted for ordinary broadside and other positions. The shield is generally used, as the gun is often placed in exposed positions. There is also a bulwark mounting for this class of gun, it being placed on the ship's rail, and can be clamped in any position. The bulwark is strong enough to well stand the comparatively small stress of firing. The same mounting is also used for military tops when there are gun positions on the mast.

We are indebted to London Engineering for the cuts and description.

FIGS. 11 AND 12.—MULE EQUIPMENT.

THE MAXIM RIFLE-CALIBER GUN.

A METHOD OF MEASURING WIND PRESSURE.*

THERE are few physical problems of greater immediate and obvious practical importance than that involved in the measurement of air pressures under complex conditions of motion, and there are few problems which present greater difficulty, or, what is worse, uncertainty. It may be comparatively easy to obtain under any particular set of circumstances evidences of barometric variation by means of some indicating instrument, apparently suitable for the particular purpose, but it is a very different matter to decide how far the quantitative result is unaffected by actions set up by the instrument itself. Thus the record of the pressure plate gives information which is of little, if any, value in relation to the distribution of pressure over a large building; while the barometer itself is capable of giving misleading indications, whether it is too effectually protected from external influences or too much exposed.

For measuring the wind pressure at any point of a structure of considerable size, a receiver or collector is required, with a convenient gage connected by a tube. It is essential that the collector should not itself give rise to compressions or rarefactions affecting the gage. To the invention of such an instrument Prof. F. E. Nipher has devoted much attention, and his final apparatus seems to fulfill its purpose admirably. Two equal thin metal disks, 2·5 inches in diameter, having beveled rims, are screwed together so as to leave a small space between, into which a connecting tube is passed through the center of one of the disks. The end of the tube is flush with the inner surface, and the interspace is filled up with a certain number of layers of fine wire screen, which project at least half an inch beyond the edges of the metal disks. When this simple device is placed in a stream of air, it is found that the effects of rarefaction and compression, set up at different parts of the porous screen, completely neutralize each other, so that the pressure at the mouth of the tube is the same as the true intrinsic pressure of the external air. This property of the collector was severely tested by thrusting it out of a carriage window in a train which was traveling at the rate of sixty miles an hour; no effect on the gage could be noticed, although the instrument was sufficiently sensitive to show instantly the effect of placing the hand at a tangent to the edge. The gage which Prof. Nipher employed was a water manometer consisting of a cylindrical vessel partly filled with water, with a straight glass tube leading out from the bottom and inclined at 5 in 100 to the horizontal. The open end of this tube was in communication with a collector of the form suggested by Abbe* so as to secure a standard pressure of comparison.

Being now satisfied with the trustworthy nature of his apparatus, Prof. Nipher determined to apply it to the determination of the distribution of pressure over a large pressure board. For this purpose the board, which was a wooden one, 4 feet long by 3 feet wide, was mounted on the roof of a railway carriage. It was bolted to a vertical iron pipe, and the couple required to keep it perpendicular to the direction of the wind was measured by a spring balance. On opposite sides of the board, and at the center of one of the 108 4-inch squares into which the board was divided, two disk collectors were fixed and connected by rubber tubes with their respective gages. The latter, together with a third, which was used as a level, were mounted on a board which was rigidly attached to a heavy pendulum within the carriage. The speed of the train varied generally between twenty and fifty miles an hour, and was checked by direct observations.

The total action on the board is the result of an increase of pressure in front and a decrease behind. Both the increase and the decrease are shown by this series of experiments to be proportional to the force necessary to hold the board to the wind as indicated by the spring balance. Further, the force measured in this way differs from that deduced from the data given by the collectors by no more than one per cent., and although this may be in a measure accidental, it affords a confirmation of the accuracy of Prof. Nipher's method. On both sides of the board the difference from the ordinary pressure becomes less as the periphery is approached, although there is some evidence of a minimum excess at the center of the front face. Prof. Nipher gives a few notes on the application of the device to the study of pressure variation around a building. It is to be hoped that such developments as this will be realized. At present it is too early to estimate the full importance of these researches as a contribution to the study of anemometry; but the idea is full of promise, and the simplicity of the apparatus is certainly a great point in its favor.—Nature.

* "A Method of Measuring the Pressure at any Point of a Structure, due to Wind Blowing against that Structure." By Francis E. Nipher. Transactions of the Academy of Science of St. Louis, vol. viii., No. 1.

* Report of the Chief Signal Officer, 1887, 2, 144.

THE PASSY RAILWAY TUNNEL.

THE construction of the new Courcelles-Champ de Mars underground railway, designed to put the center, the west and the periphery of Paris in rapid communication with the various points of the Exposition of 1900, is nearly every day meeting with exceptional obstacles.

The delays that are inevitable in every operation in which private property is taken possession of for public utility have not, in fact, allowed of waiting until it can be begun at one of its ends. It was therefore decided last August to sink seven shafts of from 65 to 80 feet in depth at different points of the line, so as to reach the level of the floor of the gallery. It is through these shafts that, by means of windlasses, the materials are let down and the excavated earth is hoisted. The engineers, the laborers and those whose rare privilege it is to be allowed to visit this interesting work, must bravely climb or descend the innumerable rounds of the primitive ladders that are arranged in the first shaft, which is sunk in the vicinity of the roadway of La Muetté.

To sink a shaft is nothing, but to determine exactly the direction line of a tunnel when the surface is in part occupied by five-story buildings is a very delicate matter. It is necessary in such a case to proceed by parallels, that is to say, after a sector of the line has been marked upon the ground (in a street, court or garden) its distance is taken from a parallel of which the prolongation serves as an indication for the continuation of the gallery. The same process is followed at several points.

In sinking shafts here and there upon the line thus obtained, and in starting galleries in opposite directions, it ought to be possible, if the operation has been properly conducted, to establish a continuous gallery. In the construction of the Passy tunnel, not the slightest deviation has been detected between the axes of the two galleries that are advancing one ahead of the other. Here, then, are two difficulties from which the contractors have extricated themselves with honor—the establishment of the direction line and the removal of the spoil. The nature of the earth was another obstacle to them. After meeting in the first place with a stratum of coarse limestone, the gallery soon penetrated plastic clay, that is to say, a material that was the least resistant and the least capable of sustaining walls of a certain weight. It was, therefore, necessary to make innovations according to the cases that presented themselves in measure as the work advanced, and to find some ingenious way out of every difficulty.

As for the spoil, that can now be very easily disposed of, thanks to the construction of a temporary wooden bridge over the Seine to connect the tunnel with the Moulineaux line, where trains carry it to a distance. However, it was not possible to make this connection at once, except through a temporary tunnel 8 feet in height, which has just been opened on Rue Guillou. A house that has not yet been condemned is an obstacle to the establishment of the final cutting that will join the great tunnel at the bridge, which, for the moment, ends at the ground floor of a seven-story house on Rue Raynouard. This provisional bridge and tunnel will cost about $30,000, a very small sum when we reflect

that the net cost of a square foot of the great tunnel (inclusive of the cost of the condemned property) will be more than $80.

The process usually employed in the construction of tunnels is, perhaps, well known. The arch is constructed first and the abutments afterward, or, in other words, a beginning is made with the roof and an ending with the foundation. Nothing is easier when the work is done in proper soil, since a little timbering suffices to sustain the arch while the walls are constructing. But the same is not the case when the operation has to be performed in friable earth. Thus, it is generally admitted that clay cannot long support more than a pound and a half to the square foot. A host of circumstances arose to still further complicate the already difficult construction of the Passy tunnel. The necessity of passing under large buildings was not one of the least; and to this must be added that of operating in a subsoil which had once been gutted by the quarrymen and architects of the seventeenth century. It was at Passy, in fact, that the courtiers and financiers had their country houses at that epoch, and woe would have been to the architect who did not give to the cellars all the importance that these fine gourmets themselves attached to them.

EXTRACTING CLAY IN THE PASSY TUNNEL.

Let us see, now, how under such conditions it was necessary to construct the tunnel.

The first operation consisted in excavating the heading. After the shaft had been sunk to the desired depth, the laborers made their way underground by pick, shovel and powder. Within the limits of Paris, the use of dynamite is forbidden and powder itself must be employed only with the greatest precaution. This first gallery had a section in the form of a regular trapezium, with a base of 8 feet and a height of about 10 feet. As soon as a slight advance had been made, the timbering was begun. The second phase was the attack of the "strosse." By "strosse" is meant the section of the earth to be removed. This operation consists in digging the gallery deeper, so as to give room for freer motion. The third phase consisted in the establishment of the rubbish galleries, the earth and rocks being removed laterally, so as to render it possible to construct the masonry of the arch. Then was begun a timbering of the interior, so much the more extensive in proportion as the section of the tunnel was relatively wider. Then the construction of the masonry was begun at the springing of the arch. At the key, this masonry is nearly 3 feet in thickness, and after construction is held for at least eighteen days by strong centerings.

It is at this moment that intervenes an operation which is very important, since it assures the solidity of the arch; this is the injection of cement. This process was employed by M. Berliner in the construction of the siphons under the Seine. It consists in filling a receptacle with very liquid cement which is not allowed to deposit, and which to this effect is constantly stirred. After the receptacle is full, it is closed hermetically. Pipes put it in connection on the one hand with the arch, where an aperture has been formed, and on the other with a pump capable of producing a thrust of six atmospheres. Under the action of the pump, the entire contents of the receptacle are projected almost instantaneously into all the surrounding cavities in the earth, which they fill, and thereby increase the resistance of the arch. Such action makes itself felt to a distance of nearly a hundred feet. Some of the laborers working in a shaft at 30 feet from the tunnel have, in a manner, been "petrified" through the coating of cement received by them!

As we have above said, clay cannot support much of a weight; so it became necessary to establish a second tunnel above the first, in order to prevent a possible caving in. Consequently, sheeted excavations were made, that is to say, at certain points, and never upon two sections placed opposite one another. Cuttings were made as far as to the level of the floor, and immediately timbered. The masonry was constructed upwardly as far as to the springing of the arches. The same process was repeated a little further along, and, in order to maintain the two walls with more certainty, the floor was at once constructed here and there.

The tunnel, when finished, will be 21 feet from the rails to the key of the arch and 29½ feet in width; but in reality it will have been necessary to excavate for a width of nearly 35 feet at the base and for a depth of 32 feet. The arch, in fact, is 3 feet in thickness at the key and the floor is 6 feet.

It remains for us to speak of the very troublesome work of the clay diggers. It was necessary to employ special laborers at wages of $2 a day in order to remove this deposit, upon which the pick has no effect. The clay digger makes use of two tools, (1) the "ancisoir," a sort of knife which he thrusts perpendicularly into the wall of clay, not without dipping it two or three times a minute into a pail of water, and (2) the "hour pin," with which he strikes the wall laterally with repeated blows in order to detach the blocks of clay that have previously been divided with the ancisoir. A good workman can extract 8 cubic feet a day. Leaving aside firedamp, the fate of the coal miner is still more enviable. There are gray-haired coal miners; are there gray-haired clay extractors? For our engravings and the above particulars we are indebted to L'Illustration.

INJECTION OF CEMENT IN THE PASSY TUNNEL.

THE VICTOR SHIELD FOR CIRCULAR SAWS.

Owing to the numerous accidents from circular saws which have been reported by certifying surgeons, the Home Office has instructed the factory inspectors to press upon occupiers of sawmills and other works in which such saws are common the absolute necessity of providing some guard for the saw itself, and it has been stipulated that merely providing boards or shutters for the frame of the saw below the table is not sufficient, with the added provision that whatever form is adopted the scheme must include a "riving knife" fixed at the back of the saw. With the object of meeting the above conditions a safety guard for circular

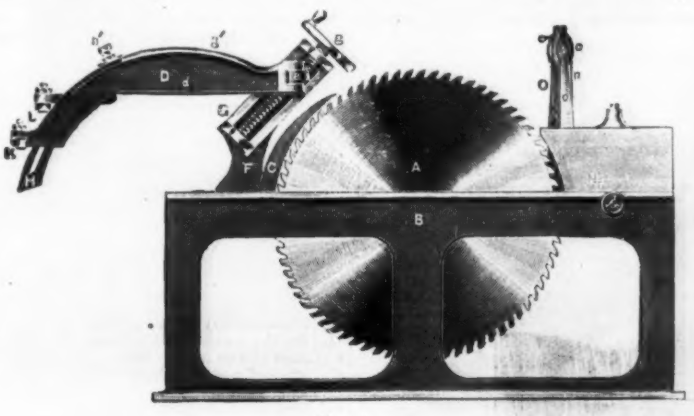
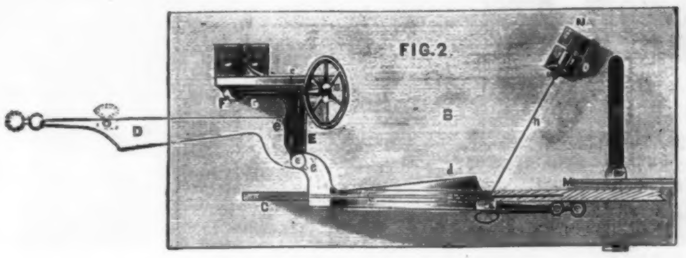


Fig. 1.



VICTOR CIRCULAR SAW SHIELD.

saws, which has been named the "Victor shield," has been patented by Mr. E. Williams, of Chester, and we have had an opportunity of seeing one of these guards in operation at a sawmill in Manchester.

The accompanying illustrations show—Fig. 1—a front elevation of a saw bench fitted with one of these guards turned back, and the saw clear, and—Fig. 2—a plan of the saw. This guard is designed entirely to cover the part of the saw above the bench; it is also so arranged that it can be adjusted to any size of saw, and can swing round out of the way—as shown—for changing saws or sharpening, and is effective when in position in preventing pieces of timber, knots, or sawdust being thrown over from the back of the saw, or any person receiving injury by accidentally falling over the saw, or coming in contact with it in any position. It is automatic in action, and the man operating at the bench can work as freely with it as without, while it does not in any way obstruct his view in feeding up the timber. The Victor shield consists of a guard constructed with a hood which covers the teeth, at front and on top, and is pivoted to a radial arm, which is supported at one end upon a screw set in an inclined position, whereby the turning of the screw raises the hood, and at the same time draws it forward, or vice versa. The hood is also fitted with a sliding extension for the front edge with a riving knife fixed at the back of the saw. Referring to our illustration, the hood is shown, D, swung out of position, and is raised or lowered by a screw, g, operated by a hand-wheel. This hood is pivoted to an arm fixed to the bench, from which it stands out at right angles, so as to be capable of swinging or opening in a horizontal plane, to allow timber to enter between it and the saw, A, at the front, and to come out under it at the back of the saw, and also to admit of its being turned into a position leaving the saw clear to be removed or sharpened. The pivot on which the hood swings is close behind the plane of the saw, so that but little force is required to open the hood to allow the timber to enter, the movement to one side for this purpose being not sufficient to uncover the saw. The bracket carrying the hood is fixed to the saw bench and the screw extends from one end to the other of a slide, and is inclined to the vertical at an angle of 45°, so that the movement of the screw to raise the arm, and with it the hood, also advances the arm and hood toward the front of the saw. This movement prevents the front edge of the hood coming into contact with the saw, when a large saw is introduced, and also prevents its standing out too far from a small saw. The length of the arm is such that the bracket can be set a considerable distance behind the saw, and thus be completely out of the way when the saw is in action, and not interfere with the free passage of timber past the saw. To the front of the hood, D, is bolted a sliding extension piece, H, by which the hood can be extended to any desired length, so that as it is raised up to accommodate a larger saw, the extension piece can be lowered to a level with the bench, B, to cover the front of the saw.

In flat cutting wide timber the extension piece, H, is lifted sufficiently high to allow the timber to pass under it, and the hood then remains stationary. A new and important feature in this guard is the introduction of a smaller roller attached to the front head of the hood, K, and arranged to guide the timber and hold to the fence the last top corner of the deal or block right up to the finish, thus avoiding the use of the hand at the most dangerous and critical part of the operation. Of course it need only be added that when this hood is in operation it is simply swung round over the saw when, with the riving knife, C, it completely covers the saw. The riving knife fixed at the back of the saw is made of steel and provided in different sizes to suit the various diameters of saws, and this knife is constructed to fit on the bench without taking up any of the gap of the saw, so that a full size saw can be used with it. For general jobbing benches, and benches sawing and converting English timber, for which it would be difficult to use these knives, an adjustable hinged piece is attached to the hood to cover the back of the saw, and to be used in place of the knife. This hinged piece lifts out of the way when the timber comes against it, and drops down again behind the saw when the timber is through, preventing any loose timber dropping on it. These guards, as we saw them in operation, appeared to be very effective in securing the object for which they have been designed, and we need only add that Messrs. Henry Wallwork & Co., of Manchester, have been appointed the sole makers for the patentee.—Engineer.

HYDRAULIC TUBE STAVING MACHINE.

Though the general introduction of water tube boilers may diminish the demand for some of the existing types of hydraulic tools, it is not likely that the use of hydraulic power will be much affected, as there are many operations connected with the new class of boiler which can very conveniently be accomplished by this agent. Thus the tool which we illustrate on this page has been introduced by Messrs. Fielding & Platt, Limited, of Gloucester, for staving or upsetting the steel tubes used in the construction of Belleville boilers. As will be seen from our engraving, the end of the tube to be treated is gripped in dies, the upper one of which is raised or lowered by means of hydraulic power. The ram which does the upsetting is driven forward by the horizontal cylinder shown. It will be seen that there are three operating valves. The one to the left controls the motion of the ram carrying the die, while the other two are used in working the upsetting ram, one admitting water to the front and the other to the back of the lower cylinder. In doing light work water is admitted to both ends of this cylinder, and the effective piston area being less in front than at the back, the ram moves forward and upsets the tube. For heavier work the front of the cylinder is opened to exhaust as soon as the working head is in contact with the end of the tube operated on, which then gets the benefit of the full area exposed to pressure at the back of the ram. The valves are of the balanced piston type, and have large waterways. The standard of the machine is, it will be seen, of the open gap type, reinforced with two columns in front, an arrangement which gives great rigidity, while leaving a very open front for the handling of the tubes. The latter can be admitted up to 12 feet in length. The machine, it should be added, weighs 23 tons.—Engineering.

PREPARATION OF CRYSTALS.

W. Tassin has reviewed the several methods of preparing crystals for the determination of their geometrical and physical constants, and groups them under the three heads: Solution, sublimation, and fusion. Solution.—In the first class, crystals of a substance are prepared from its solution in a liquid by evaporating and cooling the solution, by the reaction of soluble compounds or by chemical changes in general. The general rules to be observed are that crystallization must proceed as slowly as possible, the solution must be of the least viscosity possible, the crystallizing substance must be present in the solution in the greatest quantity, removal of the crystals should preferably be effected when the solution is at its minimum temperature, and crystals desired for measurement must be quickly and completely dried in order to prevent corrosion or etch figures forming. Sublimation.—In this case crystals may be obtained direct or a non-volatile compound may be obtained as a result of chemical action between two or more volatile substances, or from a volatile substance and a gas. Fusion.—Crystals in the third group are secured, either with or without pressure, by slowly cooling a homogeneous magma or by a solution of the substance in a molten magma.—Proc. Am. Chem. Soc., xx., 3.

HYDRAULIC TUBE-STAVING MACHINE.

THE CINEMATOGRAPH.

By JULES FUERST, in Journal of the Society of Arts.

IN introducing to your notice the Lumière cinematograph, I may state, to begin with, that to-day the subject of animated photography is so well known that, strictly speaking, nothing of a novel character is presented to the audience. I need hardly say that animated photographs have come to stay, and before dealing with the Lumière machine and its efficiency in particular, a few historic notes as to the origin of chrono-photography, or the photography of movement, may not be out of place.

In the early part of the century Platau produced an instrument termed the phenakistoscope, demonstrating the principles of the persistence of vision, and this subsequently gave rise to the zoetrope, or wheel of life, in about 1845. This instrument showed a series of images depicting the successive attitudes of objects in motion.

Later, in about 1870, the praxinoscope, by Renault, and the photographic revolver, by M. Janssen (in about 1874) appeared. At the same period M. Muybridge obtained a series of moving photographs taken by means of several dark chambers provided with lenses which were worked electrically at convenient intervals, and I believe this apparatus, or an improvement on it, was shown before this society in 1882.* Muybridge and Anschutz, by their photographic studies of animal locomotion, and the exhibition by projection of the results, undoubtedly brought us nearer to the realization of animated photography as we now know it.

Mr. Friese Greene introduced his camera for taking a series of photographs in rapid succession at the photographic convention in 1890, but the extent of its capability was not recognized then, as the pictures were not shown on the screen. Mr. Friese Greene read a paper at that time dealing with the subject of the persistence of vision and its relations to animated photographs.

It was, however, M. Marey (a Frenchman) who gave us the most successful results, having constantly utilized chrono-photography for studying the movements of animals and various physiological phenomena. There were other scientific men who worked in the same direction; it may be said, however, that all these scientists generally sought to produce successive pictures in small numbers constituting an analysis of movement and destined to be studied at leisure. The reconstitution of that movement, that is to say, the synthesis, was first commercially and practically illustrated on the appearance of the Edison kinetoscope in 1893, but the film on which the photographs were taken having a continuous movement, each picture could not be seen except during $\frac{1}{7000}$ part of a second, rendering the condition of transparency to light extremely feeble, and consequently the scenes or views had little depth—at least thirty photographs being necessary to leave a sufficiently continuous impression upon the eye.

When Lumière's cinematograph was first shown in July, 1895, in Paris, the defects mentioned had been removed, the machine permitting the reduction of the number of photographs to fifteen per second, any three of which showed movement. The working principle of the apparatus has long been well known, and is the same as with the instruments previously stated, viz., the persistence of the luminous impressions upon the retina, which is easily understood.

If we observe an object, the image in the eye is transmitted to the nervous membrane called the retina. If the object ceases to be illuminated suddenly, the image in the retina is progressively removed, and so long as it has not entirely disappeared, the optic nerve continues to be impressed, and the eye continues to see the object as if it had remained illuminated. The duration of the persistence of the luminous impression on the retina varies with the amount of light on the object; for a normal illumination it is about $\frac{1}{48}$ second, and is prolonged for another $\frac{2}{48}$ second, although the illuminated object may have disappeared suddenly. Consequently, if an illuminated object is presented to the eye and masked by an opaque screen during $\frac{1}{48}$ second for instance, its image persists in the eye $\frac{1}{48}$ second, and we do not even perceive its passing eclipse. Let us assume, therefore, a number of photographs on a film at $\frac{1}{15}$ ($\frac{3}{48}$) second intervals, showing the successive movements of an object; the various pictures obtained are like each other, that is to say, if any two thereof are superposed, the parts which represent the fixed objects are exactly the same, whereas those which correspond with the object in movement occupy positions of which the displacement has been accomplished during the time in which two pictures have been taken. Having said so much, let us assume that we have taken 900 successive proofs during a minute, and let us project the same on a screen by means of any lantern.

Let us eclipse image No. 1 by interposing between the luminous source an opaque screen which masks the light during $\frac{1}{48}$ second, and, as we have said, the eye will continue to see the projected image, not only during the whole of the passage of the opaque screen (or shutter), but even after it has passed, during the time equal to the difference between $\frac{1}{48}$ second (duration of persistence) and $\frac{1}{48}$ second (duration of the passage of the shutter), that is $\frac{1}{48}$ second. We will assume, then, that a second image has been substituted for the image No 1 when the shutter again unmasks the source of light; we still see during $\frac{1}{48}$ second image No. 1, evidently weaker, but superposed by the image No. 2, and as the immovable parts coincide exactly, our eye perceives the sensation of the moving object, attitude No. 1 succeeded by attitude No. 2.

If we substituted in the same way during successive and rapid periods No. 3 for No. 2, No. 4 for No. 3, and so on up to No. 900, it is evident that the eye sees always the same image in which the moving object passes progressively from attitude No. 1 to attitude No. 900. The eye therefore sees marching on the screen photographs of the object.

FIG. 2.—FILM WINDER.

It is necessary to have an apparatus to produce thus within one minute the 900 light eclipses by which 900 substitutions of successive images are obtained.

In Lumière's cinematograph these eclipses are obtained by means of an opaque shutter, which revolves at the rate of fifteen times in each second, and is attached so that during its movements it intercepts the light coming from the projecting lantern at each turn, and consequently the illumination on the screen on which the image is projected disappears during a fraction of $\frac{1}{15}$ second. To operate the substitution of images, the 900 successive photographs are made on a flexible film about 55 feet long and 1⅜ inch wide. The dimensions of each picture are 25 mm. wide and 20 mm. long. On either side of the film are perforations (two holes to each picture) at exact distances from each other, into which sprockets periodically penetrate with the object of pulling the film downward, and displacing it at each passage of the rotating shutter. The sprockets remount immediately in order to attack the next two holes, and so on.

It will be seen that the construction of an apparatus to accomplish such operations must be extremely exact in all its movements in order to keep the fragile film uninjured and to be capable of using films a great many times.

The Lumière instrument, thanks to the alternate movement given to the crank by an eccentric triangle (which is the fundamental part of the Lumière patent), is to-day the most unique and perfect apparatus of its kind. Thus the rapidity of departure and rapidity of stopping the sprockets is as progressive as possible. The movement of the sprockets does not commence until after the absolute rest of the film, so as to catch the perforation accurately, i. e., not to injure the holes. As a result, the film rests immovable during two-thirds of the time which separates two consecutive phases of reconstituted movement, the other one-third of the time being employed in substituting the following image.

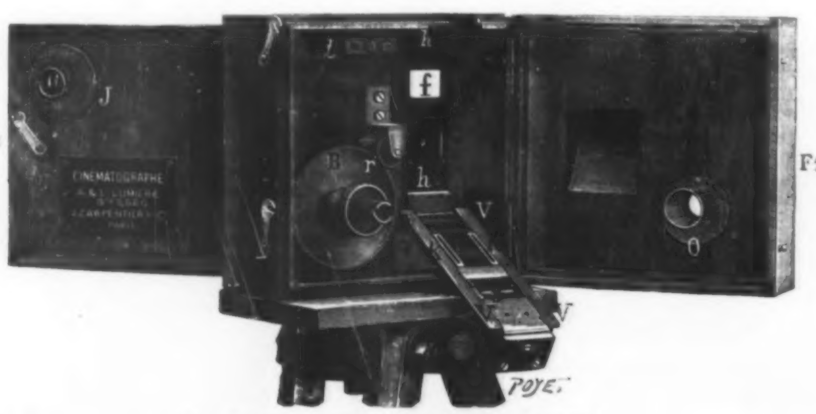


FIG. 1.—THE CINEMATOGRAPH CAMERA.

All these advantages considered, the Lumière cinematograph can be employed with all safety, and furnishes results which no other machine can give, and it is a well-known fact to-day that Lumière's films (taken with the Lumière machine) are used by nearly all those who have machines on the Edison plan, i. e., four holes to each picture, but who cannot obtain with those machines such perfect results. It may be of interest to mention that by adjusting the sprockets in Lumière's machine they take positives with Edison perforation (four holes to each picture).

A few notes on the apparatus may be of interest. The cinematograph actually is composed of two essential mechanical parts:

1. The Eccentric Crank.
2. The Sprocket Frame and Sprockets.

While the crank rotates once, the eccentric transmission rotates eight times. The crank is manipulated by a handle which the operator must turn very regularly, about two turns per second; consequently, the eccentric transmission will make sixteen turns per second.

The triangular eccentric is fixed behind the transmission, and moves the sprockets continuously in a circle. The movements of these sprockets during their rotation are slightly deformed, so as to engage the film in one case, and in the other case to disengage it. At the end of the crank is fixed a shutter, which is composed of two light metallic sections, which can be regulated so as to increase or decrease the size of the same.

Respecting accessory mechanical parts, there is a bridgelike arrangement on hinges which can be lowered or kept in position by a latch. This bridging has two springs, within which the sprockets play. It has also a square glass provided with springs which presses lightly on the film when operated, so as to avoid damage to the film in case of any unforeseen accident. The wall is provided with velvet to keep the film from deteriorating, and on the upper part of this wall is a rectangular window, which allows the image to be projected or photographed.

To obtain the negative, it is necessary to have a tripod, a dark slide, a receiving slide and a film roller.

The receiving slide is entirely made of metal, and is designed to roll up the exposed film as it is unrolled when photographing.

The film roller is used for rolling the film by hand; the film is introduced into a slit on the roller, subsequently rolled, and thus about 50 to 60 feet of the film are rolled in a few seconds.

In taking the negative the following operations are necessary:

a. Introducing the film into the dark slide.
b. Focusing the scene.
c. Attaching the film to the receiving box, after which the door is closed, and the handle inserted ready to take the scene.

Focusing the object is a very delicate operation requiring all the care of the operator. It is clear that the negative film should have the greatest possible sharpness, because the positives obtained therefrom by contact depend on it and are subject to extreme enlargement when projected. The smallest defects in the negative are very much exaggerated when projected on a large scale.

The negative lens is provided with three diaphragms —one small, one medium and one large size. The smaller the aperture of the diaphragm, the smaller is the amount of light passed, and therefore the smaller diaphragm increases the general sharpness of the image, and it is recommended therefore to use it when a sufficient amount of light is available.

A small piece of plain matte film will make a very fine ground glass screen for focusing.

DEVELOPMENT, WASHING AND FIXING THE EXPOSED FILMS.

Prepare the following developer:

Water	20 pints.
Amidol	2 oz.
Sulphite of sodium	10 "

A stock solution of water and sulphite of sodium, which keeps indefinitely, may be always kept ready, and the amidol can be added as required. The relative proportion of amidol or sulphite of sodium may also be altered to suit requirements.

The above quantity of developer is made up so as to enable the employment of ordinary sized galvanized iron pails. It is preferable that these should be enameled in white on the inner side. For development, take two pails filled with the developer. The film roll is suspended over the pail, and then passed very rapidly into the first pail, and when the end has been reached into the next pail of developer, so as to insure even development. Care must be taken that the emulsion side is touched by the fingers as little as possible.

We repeat, the operation must be performed very quickly, continuing this process of passing from one pail to another until development is complete. The time occupied by the above developer is very short. Afterward plunge the film in a pail of plain water, taking same from the second pail when doing so. Under these conditions development will be sufficiently uniform over the whole length of the film.*

The same operation is repeated in the fixing bath, the strength of which should be one in four. Once fixed, place the film in a receptacle where the water runs continuously, and it must be left in the washing for several hours.

To avoid the film contracting after it has been fixed, it requires glycerining, and the following is the formula:

Water	15 pints.
Absolute alcohol	5 "
Glycerin	10 oz.

This operation must not take longer than five minutes; the temperature for drying should be 67° to 70° Fah.

MAKING THE POSITIVES.

For this purpose a dark slide is used. This dark slide has two axles. On the lower axle the negative is placed emulsion side outward, and around the upper side the sensitive film, emulsion side inward. The two ends are passed through the slit in the box. This operation must be done in the dark room. Subsequently proceed to expose the same as for negatives, only with this difference, that the positive film alone

* Journal, vol. xxx., p. 838.

* There are various other methods and devices for developing, which need not, however, be gone into.

is introduced in the receiving slide, whereas the negative film will unroll outside, through an opening arranged at the base of the apparatus.

The shutter must be arranged so as to form a complete semicircle. To make the exposure, close the apparatus, unscrew and remove the lens, and place before the circular opening at a convenient distance, a light, either a gas flame or petroleum lamp. The distance which this light must be placed depends on the nature of its intensity and the density and transparency of the negative. No precise instructions can therefore be

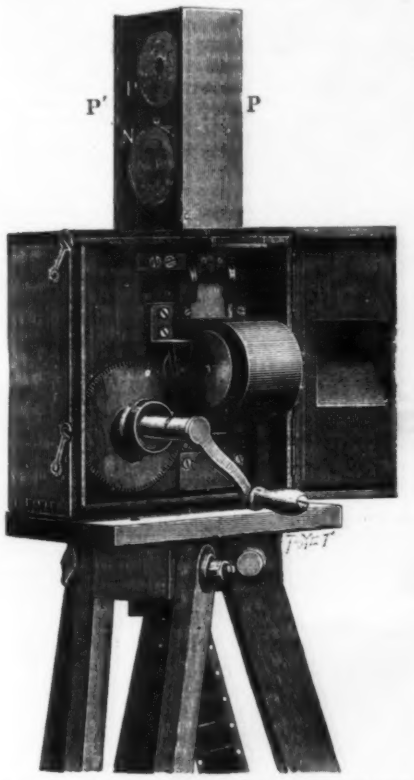


FIG. 3.—CAMERA AND PRINTING SLIDE.

given, but a few small strips exposed will give the necessary information to the operator.

PROJECTING.

The additional material necessary for projecting with the cinematograph is a projecting lens, an electric lantern, resistance coil, a stand and a screen.

The lantern, containing the regulator, is provided with a condenser, in the shape of a globular glass bottle containing water, which concentrates the light of the arc onto the projecting machine. In order to regulate the carbons, a side window is provided. The water should preferably be distilled, or a few drops of acetic acid may be added. The condenser is cased in a metal frame, fixed with four pins to the lantern, and each having a screw. The casing has a prolongation in the shape of a cylindrical tube, at the end of which is a movable window with a ground glass. This window is opened at the moment of projecting. When regulating the light, turn the globe containing the water until the light is at its maximum. This water globe replaces advantageously the glass condensing lens. As a matter of fact, the glass condensing lens has many disadvantages, and especially that of concentrating the heat rays on the film when same is stationary. By

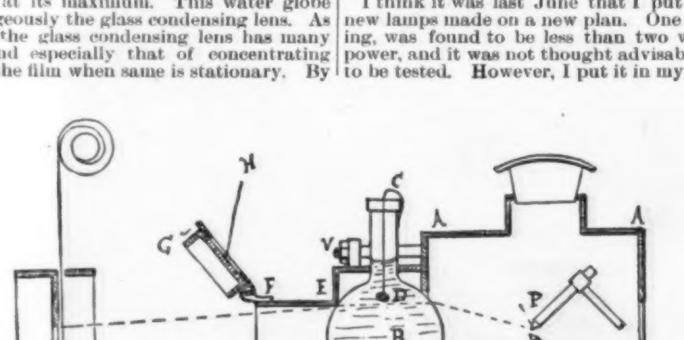


FIG. 4.—SAFETY LANTERN.

the glass globe this is avoided, as the water absorbs all the heat, and the power of lighting is increased. The light is white, the greenish coloration of the lens being suppressed. Should the water, after say about an hour, begin to boil, it is only necessary to insert a small piece of coke attached to a wire, and the evaporation will proceed with the greatest regularity.

This arrangement avoids any accidents due to carelessness on the part of the operator, as the concentrating object absorbs the heat rays.

If the projecting is done by transparency, i. e., if the screen is between the spectators and the apparatus, it is necessary to wet the same with glycerine and water in the proportion of 1 in 10. This renders the screen very transparent. These transparent projections give inverse images to those which are projected from the front of the screen.

If it is necessary to re-establish the pictures on the screen, and to show same in their proper way, that is, from the right, it suffices to turn the film so that the emulsion side is rolled inwardly.

It is hardly necessary to point out that the electric installation should be provided with safety fuses in case the current becomes too strong. We recommend the employment of continuous electric current; it is far preferable to the alternating current; in the latter case the lighting being variable and less brilliant.*

When projecting, the shutter should be placed so that the two disks cover each other exactly. This permits the maximum illumination of the screen, and care should be taken before pictures are shown that the maximum illumination on the screen is obtained from the lantern.

The films must be kept in a state of regular elasticity. For this purpose a tin box is supplied; this box has two compartments. The lower part should have a piece of felt or sponge impregnated with water, over which is placed a wire sieve, on which the circular boxes containing the films (the lids of the same being off) are placed. The films are left like this overnight, and can be used again the next day.

I might mention that, to give the audience an idea of the cost, an outlay of £80 is necessary to acquire Lumière's complete apparatus, capable of taking the negatives, making positives and projecting and reversing same. This sum also includes a number of scenes or film views, and their number can be added to by purchasing them at a further cost of about £2 10s. each view. These once purchased, and if properly handled, will last for a very long time, and it has been shown that a film is capable of being projected through the machine from 500 to 800 times, thus rendering the working of this machine extremely economical.

In conclusion, I may say there is no doubt that at no distant date those who can afford it will have their animated photographs taken, show them to their friends in their private houses, and then hand them down to posterity. The same may be said of historic events, such as the 1897 Jubilee processions, etc.

[The paper was illustrated by a varied series of animated photographs thrown upon the screen by Mr. Fuerst.]

EXPERIMENTS ON THE GLOW LAMP.†

By HIRAM S. MAXIM.

IT was, I think, about eighteen months ago that a very clever American, whom I knew to be an important man in the electric light business in the States, came to me with what purported to be a new and economical lamp. It was claimed that this lamp would save about one-third of the current. I think about six months were consumed in experimenting after the first call, before the lamps were actually brought to me in quantities to test. I purchased a quantity of lamps direct from the best known makers, and put the new lamps in competition with these, with the result that the former proved themselves to be slightly better as regards duration, but the new lamps gave more light for the energy consumed, the difference being about as $3\frac{1}{2}$ is to 4. The purchased lamps began to give out at 300 hours, and were not so long lived as I had been led to believe. Wishing to know how much current was consumed per candle power, I had various lamps tested. I also made inquiries at electric light stations. At Knightsbridge station I was informed that the average commercial lamps now in use required nearer six than five watts per candle power, notwithstanding that they claim four. I also found that there were some two and one-half watt lamps for sale by various companies, but all of these were extremely short lived. After testing the new lamps brought to me by the American, I decided that there was not enough in the invention to make it of any value, and commenced a series of experiments myself.

I think it was last June that I put up a number of new lamps made on a new plan. One of them, on testing, was found to be less than two watts per candle power, and it was not thought advisable to put this up to be tested. However, I put it in my library. It was found to be 42 candle power. At the end of about two months it had gone up to 54 candle power. It is still running, and at the last testing was 46 candle power. This is the lamp that was seen by the American newspaper reporter, and the one which has been so much discussed in the American press. While the light is still very strong, there is a slight discoloration observable in the glass, but it is of a transparent nature and does not seem to interfere to any appreciable extent with the light. I have made a great variety of lamps, and it appears that a considerable saving is obtained by the changes which I have made. I know I can save 25 per cent.; my experiments appear to show that I can even save 33 per cent. The filament is manufactured and treated on a new plan, and a new form of combined mechanical and mercury pump quickly and cheaply produces a degree of vacuity which is, I think, considerably above that employed in the ordinary commercial lamps. So far I am quite able to make lamps of 2·5 watts per candle power and below, which last a long time without any appreciable diminution of light. The usual tests are 1,000 hours, though some have been tested 1,200.

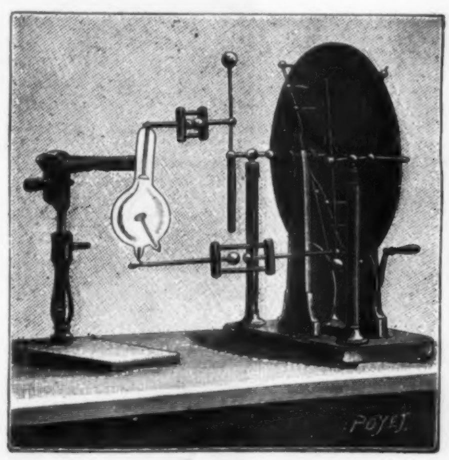
The greater part of the filament is carbon, but the resistance and tenacity is increased by the addition of a compound consisting of several substances. I have experimented with many substances. I know it has been said by those high in authority that no substance can be mixed with the filament of an incandescent lamp that cannot be volatilized out of it. Later on I shall be pleased to submit some lamps and let the parties attempt to drive out the nonconducting material that they contain. I do not think they will succeed. The new lamp promises so well that I have taken a small shop, and am now getting ready to make a quantity of the lamps. With new and improved apparatus I shall be able to make all my lamps as good as the best of them are now made. What has been done can be done again, and I see no reason why we should not put into the market a lamp which in light-giving power and lifetime will be considerably better than the best lamps now in the market. As far as patents are concerned, I presume it will take about half a dozen to cover the filament and the system and appliances for making it and preparing the lamp for the market. No patents are completed yet; they are only applied for. A great number of materials experimented with were found to be absolutely useless. I presume we shall be selling lamps inside of six months —perhaps sooner. I would say that one of the new features of the lamp is that the filaments, before being mounted in a lamp, are subjected to a much higher temperature than has been heretofore possible. This, of course, has a tendency to prevent any change taking place in the filament after it has been mounted in the lamp. It will also be understood that it only requires a very slight augmentation in the temperature in order very greatly to increase the light-giving power of lamps.

* It is quite possible, however, to use limelight with satisfactory result.

† From London Lighting.

THE STATIC MACHINE IN RADIOGRAPHIC EXPERIMENTS.

STATIC machines with condensers may answer for radiography, but if it is a question of radioscopy, there



NEW STATIC MACHINE FOR RADIOGRAPHY.

are obtained upon the screen scintillations that fatigue the eyes. Without the condensers, the static machine gives but a feeble and inadequate discharge.

The Ducretet establishment has, since 1874, been fixing to the base of the static machines that it constructs two ball columns that can be drawn out at will. These can be extended to any distance, and even be brought into contact with the balls of the exciter of the machine. In this way there are obtained sparks of variable length, which increase the tension. The columns are connected with the experimental apparatus.

In 1896, Dr. Destot used the static machine for radioscopy, and in the circuit of the apparatus arranged an interrupter formed of two balls facing each other. These balls had a certain capacity, and a discontinuous and very rapid discharge was produced between them. This arrangement gave very excellent results. The tube became intensely illuminated, and the light obtained remained nearly steady. Dr. Destot placed the conducting rods that carried the balls in a glass tube. Upon the passage of the spark, condensation and discharges upon the sides of the glass occurred.

M. Bonetti, a manufacturer of electric apparatus, has adopted the same principle and has just constructed a special apparatus, which is illustrated in the accompanying figure borrowed from La Nature.

In an ebonite insulating frame slide two metallic rods, each of which terminates in a ball. One rod is connected with one of the poles of the static machine and the other communicates with the tube.

Experiments have been made with a certain number of Crookes tubes, and the best results have been given by the "bi-anodic focus" one. The discharge may be easily regulated at will by varying the distance between the balls.

With properly arranged apparatus, a static machine with disks 18 inches in diameter has furnished the same results as an induction coil giving a 6 inch spark. The use of the static machine in experiments in radiography is, aside from the special advantages that it affords, of interest from many points of view.

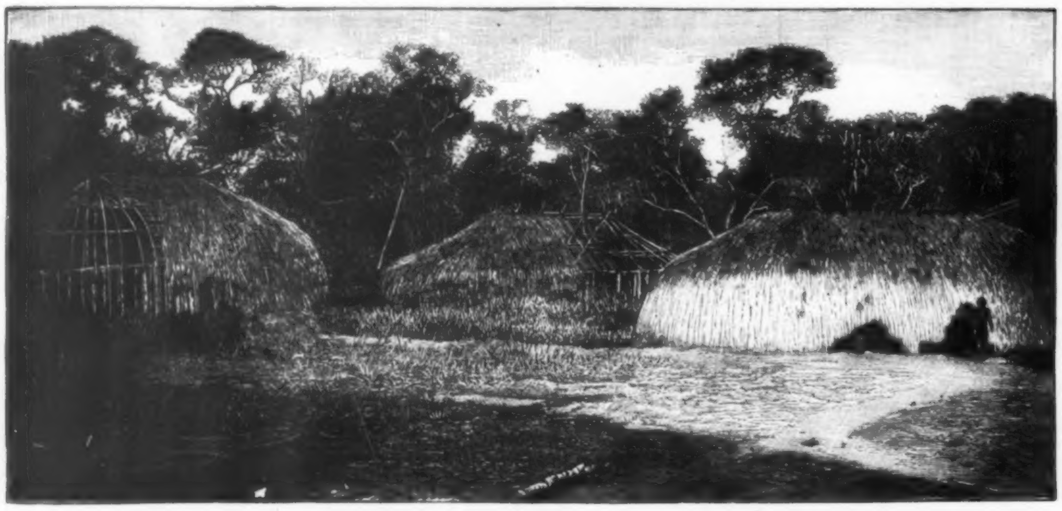
It cost $55,000 for coal to take the British cruiser "Powerful" out to China.

DR. MEYER'S EXPEDITION TO THE SOURCE OF THE XINGU.

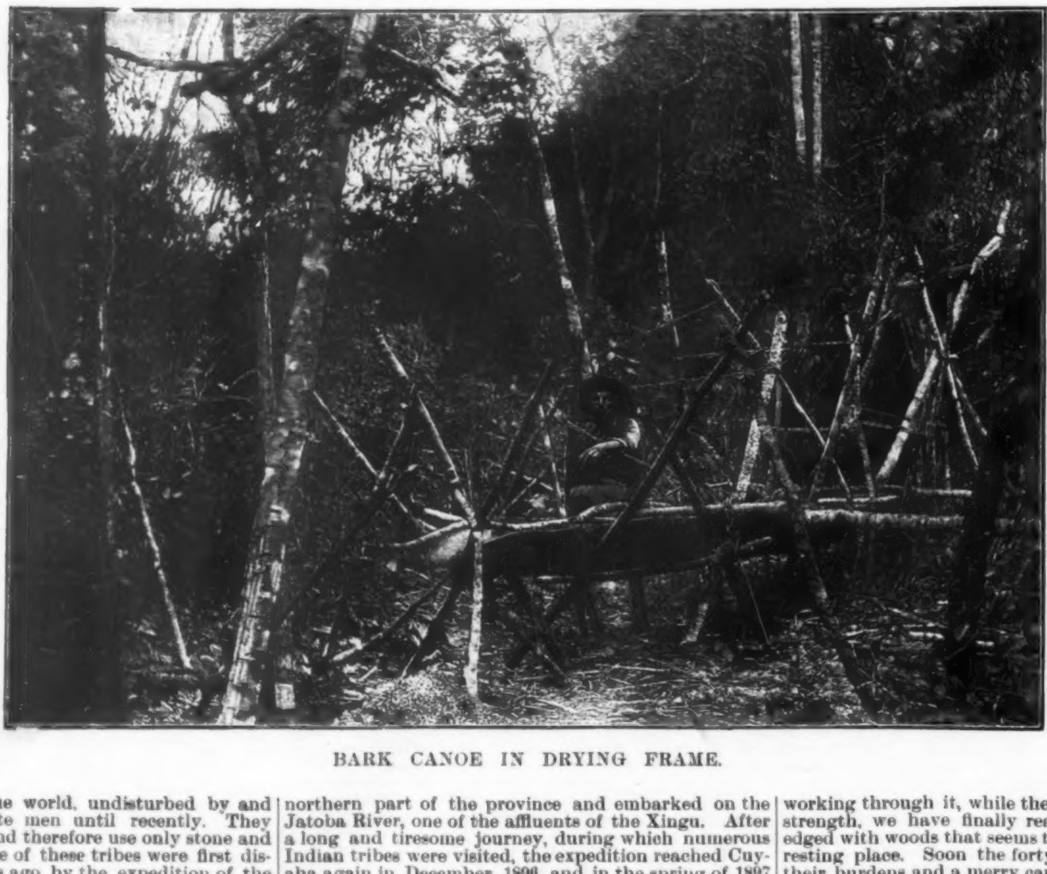
In the forests of Central Brazil, on the upper tributaries of the Xingu—one of the largest branches of the Amazon—a number of Indian tribes lead an idyllic existence, quite out of the world, undisturbed by and even unknown to white men until recently. They know nothing of iron, and therefore use only stone and bone implements. Some of these tribes were first discovered about ten years ago by the expedition of the v. d. Steinen cousins, and the object of the expedition fitted out in 1895 by Dr. Hermann Meyer, of Leipzig, was to study these tribes more closely, to explore further into the interior of the country and to determine the heretofore almost unknown geographical conditions. Dr. Karl Ranke, of Munich, accompanied the expedition as physician and anthropologist. The expedition started in May, 1896, from Cuyaba in the Province of Matto Grosso, Brazil, crossed the high plateau in the northern part of the province and embarked on the Jatoba River, one of the affluents of the Xingu. After a long and tiresome journey, during which numerous Indian tribes were visited, the expedition reached Cuyaba again in December, 1896, and in the spring of 1897 Dr. Meyer and Dr. Ranke returned to Germany with a great collection of valuable scientific material, but by a sad accident Dr. Ranke had lost the sight of one eye. Dr. Meyer took many photographs during the trip, some of which we reproduce in connection with the following description from his own pen:

"The day's work is done. After a long march over the bush steppes, on which the dry grass was so high that the mules of the caravan had great difficulty in working through it, while the burning sun sapped our strength, we have finally reached a beautiful brook edged with woods that seems to have been created for a resting place. Soon the forty animals are relieved of their burdens and a merry camp life begins. The pots over the camp fire are boiling, the succulent meat of the recently killed game roasts on the spit, the hammocks swing from the high trees, and the roomy tent

TRUMAI VILLAGE—SOURCE OF THE XINGU.



VILLAGE OF THE GUIKURU INDIANS.



BARK CANOE IN DRYING FRAME.

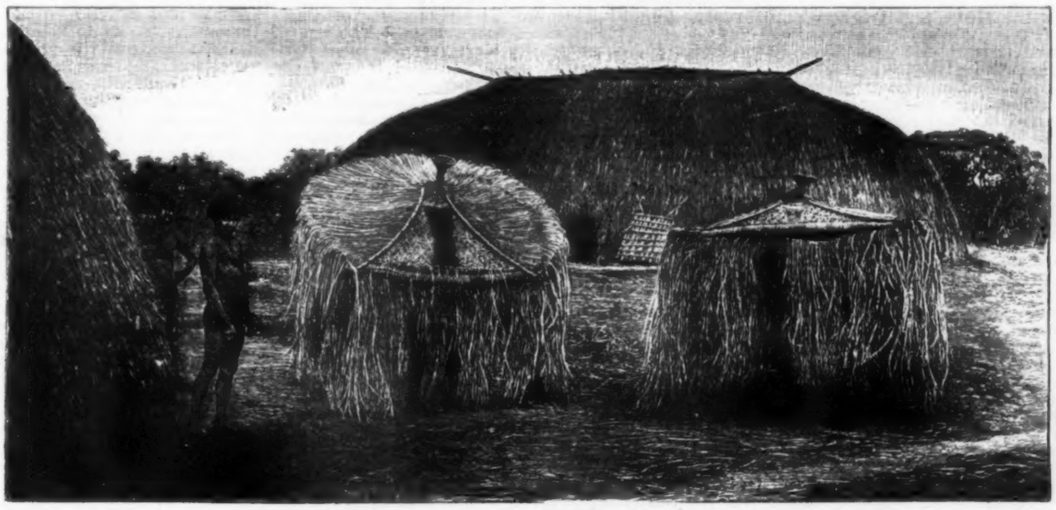
that has harbored us for seven months is changed in a trice into a cozy room. Even camp life has its poetry. When, at mealtime, we gather around the flickering fire, and the little gourd of Paraguay tea is passed around the circle, so that all may enjoy its contents through the single straw, our day's experiences are talked over, plans are made, although our thoughts turn to our homes, we would not exchange this idyl for anything on earth. A journey of six weeks over the steppes brought us to the source of the Xingu, the Jatoba River, down which we sailed, the caravan waiting on shore for our return. Canoes were made of long strips of bark, dried in frames by fire, and soon there was a fine flotilla on the river, and, indeed, great things were required of these little bark boats. More than a hundred waterfalls and rapids had to be passed and we experienced shipwreck ten times, losing much of our luggage, but at the end of the twenty-third day we reached the Ronuro, a stream that is about 900 feet to 1,300 feet wide. There we found the first Indians. Entirely removed from all civilization, these tribes are centuries behind the rest of the world; most of them have no knowledge whatever of iron. The study of such children of nature is of special interest for ethnopsychologists. They are separated into communities and live most happily. The neighboring river supplies them with good fish and they plant the manioc in the clearings they have made in the woods by means of their stone hatchets. From this plant they obtain a very nourishing, coarse meal. Several families live in each of the large, clean huts, which consist of wooden frames covered with straw and look like gigantic beehives. The hammocks are hung in groups near a small fire. These people are often well developed and have fine features; the men, particularly, are broad shouldered and muscular, and their glossy, bronze-like skin is often decorated with paintings, or at least has red oil paint rubbed in it. The straight black hair is cut off over the ears, and the crowns of their heads are shaved. The Xingu Indian is specially magnificent in his gala paint and crown of feathers when ready for a dance or other festivity. Their dances, which are always executed in groups and are accompanied by a monotonous song, serve to celebrate certain joyful events, such as the completion of a house, an abundant harvest, a successful fishing expedition, or the feast of the boring of children's ears, etc.

"One of the pictures shows a Javari dancer of the Kamayura with his casting board and the arrows used with it, which was formerly a dangerous weapon but has now given way to the bow, being used only in a kind of tournament with a dance for which several tribes come together. Some kind of decoration is always used in the dances, a partiality being shown for the remarkable dancing masks made of wood, painted basketwork or fabric. Two special monster masks which surround the entire body of the dancer and look like mushrooms are shown in another picture.

"During the six months that the expedition worked

JAVARI DANCER WITH CASTING BOARD AND ARROWS.

in the region of the source of the Xingu a number of geographical discoveries were made, and many careful anthropological and ethnological notes relating to ten different tribes, and a large ethnological collection were carried back to Germany. The work in the Xingu district will be carried on by another expedition which will start next August, making its objective point the Paranayuba, an affluent of the Xingu which has not yet been explored and along which a large number of wholly unknown tribes are supposed to live. The results of the two expeditions will be collected in one book."—Illustrirte Zeitung.



DANCING MASKS OF AUETÖ INDIANS.

FLOTILLA OF CANOES ON THE JATOBA RIVER.

THE DEBT OF THE WORLD TO PURE SCIENCE.*

THE fundamental importance of abstruse research receives too little consideration in our time. The practical side of life is all-absorbent; the results of research are utilized promptly, and full recognition is awarded to the one who utilizes, while the investigator is ignored. The student himself is liable to be regarded as a relic of medieval times, and his unconcern respecting ordinary matters is serviceable to the dramatist and newspaper witlet in their times of need.

Yet every thoughtful man, far away as his calling may be from scientific investigation, hesitates to accept such judgment as accurate. Not a few, engrossed in the strife of the market place, are convinced that, even from the selfish standpoint of mere enjoyment, less gain is found in amassing fortunes or in acquiring power over one's fellows than in the effort to solve nature's problems. Men scoff at philosophical dreamers, but the scoffing is not according to knowledge. The exigencies of subjective philosophy brought about the objective philosophy. Error has led to the right. Alchemy prepared the way for chemistry; astrology for astronomy; cosmogony for geology. The birth of inductive science was due to the necessities of deductive science, and the greatest development of the former has come from the trial of hypotheses belonging in the borderland between science and philosophy.

My effort this evening is to show that discoveries, which have proved all-important in secondary results, did not burst forth full grown; that in each case they were, so to say, the crown of a structure reared painfully and noiselessly by men indifferent to this world's affairs, caring little for fame and even less for wealth. Facts were gathered, principles were discovered, each falling into its own place until at last the brilliant crown shone out and the world thought it saw a miracle.

This done, I shall endeavor to draw a moral, which it is hoped will be found worthy of consideration.

The heavenly bodies were objects of adoration from the earliest antiquity; they were guides to caravans on the desert as well as to mariners far from land; they marked the beginning of seasons or, as in Egypt, the limits of vast periods embracing many hundreds of years. Maps were made thousands of years ago showing their positions; the path of the sun was determined rudely; the influence of the sun and moon upon the earth was recognized in some degree and their influence upon man was inferred. Beyond these matters, man, with unaided vision and with knowledge of only elementary mathematics, could not go.

Mathematical investigations by Arabian students

* Presidential address delivered at the annual meeting of the New York Academy of Sciences, February 28, 1898.—From Science.

prepared the means by which, after Europe's revival of learning, one, without wealth, gave a new life to astronomy. Copernicus, early trained in mathematics during the last thirty years of his life spent the hours stolen from his work as a clerk and charity physician in mathematical and astronomical studies, which led him to reject the complex Ptolemaic system and to accept, in modified form, that bearing the name of Pythagoras. Tycho Brahe followed. A mere stargazer at first, he became an earnest student, improved the instruments employed, and finally secured recognition from his sovereign. For twenty-five years he sought facts, disregarding none, but seldom recognizing economic importance in any. His associate, Kepler, profiting by his training under Brahe, carried the work far beyond that of his predecessors—and this in spite of disease, domestic sorrows and only too frequent experience of abject poverty. He divested the Copernican hypothesis of many crudities and discovered the laws which have been utilized by astronomers in all phases of their work. He ascertained the causes of the tides, with the aid of the newly invented telescope made studies of eclipses and occultations and just missed discovering the law of gravitation. He laid the foundation for practical application of astronomy to every-day life.

In the eighteenth century astronomy was recognized by governments as no longer of merely curious interest and its students received abundant aid. The improvement of the telescope, the discovery of the law of gravitation and the invention of logarithms had made possible the notable advances marking the close of the seventeenth century. The increasing requirements of accuracy led to exactness in the manufacture of instruments, to calculation and recalculation of tables, to long expeditions for testing methods as well as conclusions, until finally the suggestion of Copernicus, the physician, and of Kepler, the ill-fed invalid, became fact, and astronomical results were utilized to the advantage of mankind. The voyager on the ocean and the agriculturist on land alike reap benefit from the accumulated observations of three centuries, though they know nothing of the principles or of the laborers by whom the principles were discovered. The regulation of chronometers as well as the fixing of boundary lines between great nations is determined by methods due to slow accumulation of facts, slower development in analysis and calculation and even slower improvement in instruments.

Galvani's observations that frogs' legs twitch when near a friction machine in operation led him to test the effect of atmospheric electricity upon them. The instant action brought about the discovery that it was due, not to atmospheric influence, but to a current produced by contact of a copper hook with an iron rail. Volta pursued the investigation and constructed the pile which bears his name. With this, modified, Davy, in 1807, decomposed potash and soda, thereby isolating potassium and sodium. This experiment, repeated successfully by other chemists, was the precursor of many independent investigations, which directed to many lines of research, each increasing in interest as it was followed.

Volta's crown of cups expanded into the clumsy trough batteries which were displaced finally in 1836 by Daniell's constant battery, using two fluids, one of which was cupric sulphate. De la Rue observed that, as the sulphate was reduced, the copper was deposited on the surface of the outer vessel and copied accurately all markings on that surface. Within two or three years Jacobi and Spencer made the practical application of this observation by reproducing engravings and medals. Thus was born the science of electro-metallurgy. At first mere curiosities were made, then electro-plating in a wider way, the electrotype, the utilization of copper to protect more easily destructible metals, the preparation of articles for ornament and utility by covering baser metals with copper or silver or gold, while now the development of electro-generators has led to wide applications in the reduction of metals and to the saving of materials which otherwise would go to waste.

Oersted, in 1819–1820, puzzling over the possible relations of voltaic electricity to magnetism, noticed that a conductor carrying an electrical current becomes itself a magnet and deflects the needle. Sturgeon, working along the same lines, found that soft iron inclosed in a coil, through which a current passes, becomes magnetic, but loses the power when the current ceases. This opened the way for our own Henry's all-important discovery of the reciprocating electro-magnets and the vibrating armature—the essential parts of the magnetic telegraph. Henry actually constructed a telegraph in 1832, winding the wires around his class room in Albany and using a bell to record the making and breaking signals. Here, as he fully recognized, was everything but a simple device for receiving signals.

Several years later Prof. Morse, dreaming night and day of the telegraph, was experimenting with Moll's electro-magnet and finding only discouragement. His colleague, Prof. Gale, advised him to discard the even then antiquated apparatus and to utilize the results given in Henry's discussion. At once the condition was changed, and soon the ingenious recording instrument bearing Morse's name was constructed. Henry's scientific discoveries were transmuted by the inventor's ingenuity into substantial glory for Morse and proved a source of inconceivable advantage to the whole civilized world. Steinhal's discovery that the earth can be utilized for the return current completed the series of fundamental discoveries, and since that time everything has been elaboration.

Oersted's discovery respecting the influence of an electric current, closely followed by that of Arago in the same direction, opened the way for Faraday's complete discovery of induction, which underlies the construction of the dynamo. This ascertained, the province of the inventor was well defined—to conjure some mechanical appliance whereby the principle might be utilized. But here, as elsewhere, the work of discovery and that of invention went on almost pari passu; the results of each increased those of the other. The distance from the Clark and Page machines of the middle thirties, with their cumbrous horseshoe magnets and disproportionate expenditure of power, to the Siemens machine of the fifties was long; but it was no leap. In like manner, slow steps marked progress thence to the Gramme machine, in which one finds the outgrowth of many years of labor by many men, both investigators and inventors. In 1870, forty years after Faraday's announcement of the basal principle, the stage was reached whence progress could be rapid. Since that time the dynamo has been brought into such a stage of efficiency that the electro-motor seems likely to displace not merely the steam engine, but also other agencies in direct application of force. The horse is passing away and the trolley road runs along the country highway; the longer railways are considering the wisdom of changing their power; cities are lighted brilliantly where formerly the gloom invited highwaymen to ply their trade; and even the kitchen is invaded by new methods of heating.

Long ago it was known that, if the refining of pig iron be stopped just before the tendency to solidify became pronounced, the wrought iron is more durable than that obtained in the completed process. Thus imperfectly refined metal was made frequently, though unintentionally and ignorantly. A short railroad in southwestern Pennsylvania was laid in the middle sixties with iron rails of light weight. A rail's life in those days rarely exceeded five years; yet some of those light rails were in excellent condition almost fifteen years afterward, though they had carried a heavy coke traffic for several years. But this process was uncertain, and the best puddlers could never tell when to stop the process in order to obtain the desired grade.

When a modification of this refining process was attempted on a grand scale, almost contemporaneously by Martien in this country and Bessemer in England, the same uncertainty of product was encountered; sometimes the process was checked too soon, at others pushed too far. Here the inventor came to a halt. He could use only what was known and endeavor to improve methods of application. Under such conditions the Bessemer process was apparently a hopeless failure. Another, however, utilized the hitherto ignored work of the closet investigator. The influence of manganese in counteracting the effects of certain injurious substances and its relation to carbon when present in pig iron were understood as matters of scientific interest. Mushet recognized the bearing of these facts and used them in changing the process. His method proved successful; but, with thorough scientific forgetfulness of the main chance, he neglected to pay some petty fees at the Patent Office, and so reaped neither profit nor popular glory for his work.

The Mushet process having proved the possibility of immediate and certain conversion, the genius of the inventor found full scope. The change in form and size of the converter, the removable base, the use of trunnions and other details, largely due to the American Holley, so increased the output and reduced the cost that Bessemer steel soon displaced iron, and the world passed from the age of iron into the age of steel.

Architectural methods have been revolutionized. Buildings ten stories high are commonplace; those of twenty no longer excite comment, and one of thirty arouses no more than a passing pleasantry respecting possibilities at the top. Such buildings were almost impossible a score of years ago, and the weight made the cost prohibitive. The increased use of steel in construction seems likely to preserve our forests from disappearance.

In other directions the gain through this process has been more important. The costly, short-lived iron rail has disappeared and the durable steel rail has taken its place. Under the moderate conditions of twenty-five years ago, iron rails rarely lasted for more than five years; in addition, the metal was soft, the limit of load was reached quickly, and freight rates, though high, were none too profitable.

But all changed with the advent of steel rails as made by the American process. Applications of abstruse laws, discovered by men unknown to popular fame, enabled inventors to improve methods and to cheapen manufacture until the first cost of steel rails was less than that of iron. The durability of the new rails and their resistance to load justified increased expenditure in other directions to secure permanently good conditions of the roadbed. Just here our fellow member, Mr. P. H. Dudley, made his contribution, whose importance can hardly be overestimated. With his ingenious recording apparatus, it is easy to discover defects in the roadway and to ascertain their nature, thus making it possible to devise means for their correction and for preventing their recurrence. The information obtained by use of this apparatus has led him to change the shape and weight of rails, to modify the type of joints and the methods of ballasting, so that now a roadbed should remain in good condition and even improve during years of hard use.

But the advantages have not inured wholly to the railroad companies. It is true that the cost of maintenance has been reduced greatly; that locomotives have been made heavier and more powerful; that freight cars carry three to four times as much as they did twenty-five years ago, so that the whole cost of operation is very much less than formerly. But where the carrier has gained one dollar the consumer and shipper have gained hundreds of dollars. Grain and flour can be brought from Chicago to the seaboard as cheaply by rail as by water. The farmer in Dakota raises wheat for shipment to Europe. Coal mined in West Virginia can be sold on the docks of New York at a profit for less than half the freight of twenty-five years ago. Our internal commercial relations have been changed, and the revolution is still incomplete. The influence of the Holley-Mushet-Bessemer process upon civilization is hardly inferior to that of the electric telegraph.

Sixty years ago an obscure German chemist obtained an oily liquid from coal tar oil, which gave a beautiful tint with calcium chloride. Five years later another separated a similar liquid from a derivative of coal tar oil. Still later Hofmann, then a student in Liebig's laboratory, investigated these substances and proved their identity with an oil obtained long before by Zinin from indigo, and applied to them all Zinin's term, anilin. The substance was curiously interesting, and Hofmann worked out its reactions, discovering that with many materials it gives brilliant colors. The practical application of these discoveries was not long delayed, for Perkins made it in 1856. The marvelous dyes, beginning with magenta and solferino, have become familiar to all. The anilin colors, especially the reds, greens and blues, are among the most beautiful known. They have given rise to new industries and have expanded old ones. Their usefulness led to deeper studies of coal tar products, to which is due the discovery of such substances as antipyrin, phenacetin, ichthyol and saccharin, which have proved so important in medicine.

One is tempted to dwell for a little upon meteorology, that borderland where physics, chemistry and geology meet, and to speak of the signal service system, the outgrowth of the studies of an obscure school teacher in Philadelphia, but the danger of trespassing too far upon your endurance makes proper only this passing reference.

While men of wealth and leisure wasted their energies in literary and philosophical discussions respecting the nature and origin of things, William Smith, earning a living as a land surveyor, plodded over England, anxious only to learn, in no haste to explain. His work was done honestly and slowly; when finished as far as possible with his means, it had been done so well that its publication checked theorizing and brought men back to study. His geological map of England was the basis upon which the British survey began to prepare the detailed sheets showing Britain's mineral resources.

In our country Vanuxem and Morton early studied the New Jersey Cretaceous and Eocene, containing vast beds of marl. Scientific interest was aroused and eventually a geological survey of the State was ordered by the legislature. The appropriation was insignificant, and many of the legislators voted for it, hoping that some economic discovery might be made to justify their course in squandering the people's money. Yet there were lingering doubts in their minds, and some found more than lingering doubts in the minds of their constituents. But when the marls were proved to contain materials which the chemist Liebig had shown to be all-important for plants, the conditions were changed and criticism ceased. The dismal sands of eastern New Jersey, affording only a scanty living for pines and grasses, were converted, by application of the marl, into gardens of unsurpassed fertility.

Vanuxem's study of the stratigraphy and Morton's study of the fossils had made clear the distribution of the marls, and the survey scattered the information broadcast.

Morton and Conrad, with others scarcely less devoted, labored in season and out of season to systematize the study of fossil animals. There were not wanting educated men who wondered why students of such undoubted ability wasted themselves in trifling employment instead of doing something worthy of themselves, so as to acquire money and fame. Much nearer to our own time there were wise legislators who questioned the wisdom of "wasting money on pictures of clams and salamanders," though the same men appreciated the geologist who could tell them the depth of a coal bed below the surface.

But the lead diggers of Illinois and Iowa long ago learned the use of paleontology, for the "lead fossil" was their guide in prospecting. The importance and practical application of this science, so largely the outgrowth of unappreciated toil in this country as well as in Europe, is best told in Prof. Hall's reply to a patronizing politician's query:

"And what are your old fossils good for?"

"For this—take me blindfolded in a balloon; drop me where you will, if I can find some fossils, I'll tell you in ten minutes for what minerals you may look and for what minerals you need not look."

Many regard botany as a pleasing study, well fitted for women and dilettanti, but hardly deserving attention by strong men. Those who speak thus only exercise the prerogative of ignorance, which is to despise that which one is too old or too lazy to learn. The botanist's work is not complete when the carefully gathered specimen has been placed in the herbarium with its proper label. That is but the beginning, for he seeks the relations of plants in all phases. In seeking these he discovers facts which often prove to be of cardinal importance. The rust which destroys wheat in the last stage of ripening, the disgusting fungus which blasts Indian corn, the poisonous ergot in rye, the blight of the pear and other fruits, fall as much within the botanist's study as do the flowers in the garden or the sequoias of the Sierra. Not a few of the plant diseases which have threatened famine or disaster have been studied by botanists unknown to the world, whose explanations have led to palliation or cure.

The ichthyologist, studying the habits of fishes, discovered characteristics which promptly commended themselves to men of practical bent. The important industry of artificial fertilization and the transportation of fish eggs, which has enabled man to restock exhausted localities and to stock new ones, is but the outgrowth of closet studies which have shown how to utilize Nature's superabundant supply.

The entomologist has always been an interesting phenomenon to a large part of our population. Insects of beauty are attractive, those of large size are curious, while many of the minuter forms are efficient in gaining attention. But that men should devote their lives to the study of the unattractive forms is to many a riddle. Yet entomology yields to no branch of science in the importance of its economic bearings. The study of the life habits of insects, their development, their food, their enemies, a study involving such minute detail as to shut men off from many of the pleasures of life and to convert them into typical students, has come to be so fraught with relations to the public weal that the State Entomologist's mail has more anxious letters than that of any other officer.

Insects are no longer regarded as visitations from an angry deity, to be borne in silence and with penitential awe. The intimate study of individual groups has taught in many cases how to antagonize them. The scab threatened to destroy orange culture in California; the Colorado beetle seemed likely to ruin one of our important food crops; minute aphides terrified raisers of fruit and cane in the Sandwich Islands. But the scab is no longer a frightful burden in California; the potato bug is now only an annoyance, and the introduction of lady birds swept aphides from the Sandwich Islands. The gypsy moth, believed for more than a hundred years to be a special judgment, is no longer thought of as more than a very expensive nuisance. The curculio, the locust, the weevil, the chinch bug and others have been subjected to detailed investigation. In almost all cases methods have been devised whereby the ravages have been diminished. Even the borers, which endangered some of the most import-

ant timber species, are now understood, and the possibility of their extermination has been changed into probability.

Having begun with the "infinitely great," we may close this summary with a reference to the "infinitely small." The study of fermentation processes was attractive to chemists and naturalists, each claiming ownership of the agencies. Pasteur, with a patience almost incredible, revised the work of his predecessors and supplemented it with original investigations, proving that a very great part of the changes in organic substances exposed to the atmosphere are due primarily to the influence of low animals or plants whose germs exist in the atmosphere.

One may doubt whether Pasteur had any conception of the possibilities hidden in his determination of the matters at issue. The canning of meats and vegetables is no longer attended with uncertainty, and scurvy is no longer the bane of explorers; pork, which has supplied material for the building of railroads, the digging of canals, the construction of ships, can be eaten without fear. Flavorless butter can be rendered delicious by the introduction of the proper bacteria; sterilized milk saves the lives of many children; some of the most destructive plagues are understood and the antidotes are prepared by the culture of antagonistic germs; antiseptic treatment has robbed surgery of half its terrors, and has rendered almost commonplace operations which, less than two decades ago, were regarded as justifiable only as a last resort. The practice of medicine has been advanced by outgrowths of Pasteur's work almost as much as it was by Liebig's chemical investigations more than half a century ago.

In this review the familiar has been chosen for illustration in preference to the wonderful, that your attention might not be diverted from the main issue, that the foundation of industrial advance was laid by workers in pure science, for the most part ignorant of utility and caring little about it. There is here no disparagement of the inventor; without his perception of the practical and his powers of combination the world would have reaped little benefit from the student's researches. But the investigator takes the first step and makes the inventor possible. Thereafter the inventor's work aids the investigator in making new discoveries, to be utilized in their turn.

Investigation, as such, rarely receives proper recognition. It is usually regarded as quite a secondary affair, in which scientific men find their recreation. If a geologist spends his summer vacation in an effort to solve some perplexing structural problem, he finds, on his return, congratulations because of his glorious outing; the astronomer, the physicist and the chemist are all objects of semi-envious regard, because they are able to spend their leisure hours in congenial amusements; while the naturalist, enduring all kinds of privation, is not looked upon as a laborer, because of the physical enjoyment which most good people think his work must bring.

It is true that investigation, properly so called, is made secondary, but this is because of necessity. Scientific men in government service are hampered constantly by the demand for immediately useful results. Detailed investigation is interrupted because matters apparently more important must be considered. The conditions are even more unfavorable in most of our colleges and none too favorable in our greater universities. The "literary leisure" supposed to belong to college professors does not fall to the lot of teachers of science, and very little of it can be discovered by college instructors in any department. The intense competition among our institutions requires that professors be magnetic teachers, thorough scholars, active in social work, and given to frequent publication, that, being prominent, they may be living advertisements of the institution. How much time, opportunity or energy remains for patient investigation some may be able to imagine.

The misconception respecting the relative importance of investigation is increased by the failure of even well educated men to appreciate the changed conditions in science. The ordinary notion of scientific ability is expressed in the popular saying that a competent surgeon can saw a bone with a butcher knife and carve muscle with a handsaw. Once, indeed, the physicist needed little aside from a spirit lamp, test tubes and some platinum wire or foil; low power microscopes, small reflecting telescopes, rude balances and home-made apparatus certainly did wonderful service in their day; there was a time when the finder of a mineral or fossil felt justified in regarding it as new and in describing it as such; when a psychologist needed only his own great self as a basis for broad conclusions respecting all mankind. All of that belonged to the infancy of science, when little was known and any observation was liable to be a discovery; when a Humboldt, an Arago or an Agassiz was possible. But all is changed; workers are multiplied in every land; study in every direction is specialized; men have ceased the mere gathering of facts and have turned to the determination of relations. Long years of preparation are needed to fit one to begin investigation; familiarity with several languages is demanded; great libraries are necessary for constant reference, and costly apparatus is essential even for preliminary examination. Where tens of dollars once supplied the equipment in any branch of science, hundreds, yes thousands, of dollars are required now.

Failure to appreciate the changed conditions induces neglect to render proper assistance. As matters now stand, even the wealthiest of our educational institutions cannot be expected to carry the whole burden, for endowments are insufficient to meet the too rapidly increasing demand for wider range of instruction. It is unjust to expect that men, weighted more and more by the duties of science teaching, involving, too often, much physical labor from which teachers of other subjects are happily free, should conduct investigations at their own expense and in hours devoted by others to relaxation. Even were the pecuniary cost comparatively small, to impose that would be unjust, for, with few exceptions, the results are given to the world without compensation. Scientific men are accustomed to regard patents much as regular physicians regard advertising.

America owes much to closet students as well as to educated inventors who have been trained in scientific modes of thought. The extraordinary development of our material resources—our manufacturing, mining and transporting interests—shows that the strengthening of our educational institutions on the scientific side brings actual profit to the community. But most of this strengthening is due primarily to unremunerated toil of men dependent on the meager salary of college instructors or government officials in subordinate positions. Their aptitude to fit others for usefulness, coming only from long training, was acquired in hours stolen from sleep or from time needed for recuperation. But the labors of such men have been so fruitful in results that we can no longer depend on the surplus energy of scientific men, unless we consent to remain stationary. If the rising generation is to make the most of our country's opportunities, it must be educated by men who are not compelled to acquire aptness at the cost of vitality. The proper relation of teaching labor to investigation labor should be recognized, and investigation, rather than social, religious or political activity, should be a part of the duty assigned to college instructors.

Our universities and scientific societies ought to have endowments specifically for aid in research. The fruits of investigations due to Smithson's bequest have multiplied his estate hundreds of times over to the world's advantage. He said well that his name would be remembered long after the names and memory of the Percy and Northumberland families had passed away.

Hodgson's bequest to the Smithsonian is still too recent to have borne much fruit, but men already wonder at the fruitfulness of a field supposed to be well explored. Nobel knew how to apply the results of science; utilizing the chemist's results, he applied nitro-glycerine to industrial uses; similarly he developed the petroleum industry of Russia, and, like that of our American petroleum manufacturers, his influence was felt in many other industries of his own land and of the Continent. At his death he bequeathed millions of dollars to the Swedish Academy of Sciences, that the income might be expended in encouraging pure research. Smithson, Hodgson and Nobel have marked out a path which should be crowded with Americans.

The endowment of research is demanded now as never before. The development of technical education, the intellectual training of men to fit them for positions formerly held by mere tyros, has changed the material conditions in America. The surveyor has disappeared—none but a civil engineer is trusted to lay out even town lots; the founder at an iron furnace is no longer merely a graduate of the casting house—he must be a graduate in metallurgy; the manufacturer of paints cannot intrust his factory to any but a chemist of recognized standing; no graduate from the pick is placed in charge of mines—a mining engineer alone can gain confidence; and so everywhere. With the will to utilize the results of science there has come an intensity of competition in which victory belongs only to the best equipped. The profit awaiting successful inventors is greater than ever and the anxious readiness to apply scientific discoveries is shown by the daily records. The Roentgen rays were seized at once and efforts made to find profitable application; the properties of zirconia and other earths interested inventors as soon as they were announced; the possibility of telegraphing without wires incited inventors everywhere as soon as the principle was discovered.

Nature's secrets are still unknown and the field for investigation is as broad as ever. We are only on the threshold of discovery, and the coming century will disclose wonders far beyond any yet disclosed. The atmosphere, studied by hundreds of chemists and physicists for a full century, proved for Rayleigh and Ramsay an unexplored field within this decade. We know nothing yet. We have gathered a few large pebbles from the shore, but the mass of sands is yet to be explored.

And now the moral has been drawn. The pointing is simple. If America, which, more than other nations, has profited by science, is to retain her place, Americans must encourage, even urge, research; must strengthen her scientific societies and her universities, that under the new and more complicated conditions her scientific men and her inventors may place and keep her in the front rank of nations.

JOHN J. STEVENSON.
New York University.

POISONS AND POISONERS.

THERE has attached to the subject of poisons from the earliest ages an interest and importance both deep and easily to be accounted for. The mysterious and terrible power of dealing death in a cup of wine, a dish of food, a breath of perfume, even, or by the needle scratch of a poisoned weapon—all these, combined with the absence of antidotes, and the lack of all certain knowledge of the mode of action, the terrible pain and quickly fatal termination of the tragedy, have combined to attract and fix a fascinated attention to the subject.

It would seem that the first poisonous effects noticed were due to blood poisoning from infected wounds. The term "toxicology" (the science of poisons) is derived from the Greek word for a weapon or bow. The savage probably found that the weapon, when stained with the blood of former victims, inflicted more deadly wounds than when clean. The next step would be to smear the blade with all manner of evil-smelling pastes, and with the juices of plants deemed unfit for food. Many of these would be quite innocuous, but continual experiments in corpore vili would point to the effective ones. Examples of this class of poison still exist in the wourali poison of the South American natives, described by the great naturalist Waterton as a fearsome mixture of the juice of a poisonous vine containing a substance similar to strychnine, now known to chemists as "curarine," the pounded bodies of red ants, the fangs of serpents, etc. Mystic rites attend the fabrication of the drug; the hut in which the operation is conducted is deserted, all vessels used are burnt, and the secret of the process is carefully preserved from coming to the knowledge of the women of the tribe. The last two seem to be reasonable precautions. The natives of the Malay Archipelago use the dried juice of a tree, the Antiaris toxicaria, as an arrow poison, and similar compounds are found in use by the Andaman islanders, the bushmen of South Africa, and by the dwarf race described by Stanley in Central Africa.

From the poisoned weapon, dealing its slight but deadly wound, it is not a long step to the more subtle and much less easily detected method of administering poison in food or drink. Here the limitations are more stringent. Such a poison must have little taste, so as not to excite suspicion at the time of consuming the deadly food or drink. It should be free from any immediate irritant effect, and the symptoms should simulate those of some common disorder. Such a substance has for long ages been known in India, in the Datura (Sanskrit, Dhatoora) class of plants. Three varieties are common, Datura alba, D. fastuosa and D. ferox. All yield the drug atropine, well named after the eldest of the three Fates, whose duty it is to cut short the thread of life at its appointed place. Datura was frequently used in India for the purpose of terminating domestic quarrels, and to this practice may be traced the origin of the custom of "suttee" or widow burning. The Brahmin priesthood, who were also the law-giving class, found that, by making a wife's life conterminous with the husband's, the average husband lived considerably the longer. The drug also held an important place as a state agent. The effect of a number of doses insufficient to kill is to cause insanity, thus affording a ready means of rendering harmless subjects deemed too powerful and influential.

The ancient Egyptians were acquainted with prussic acid prepared from peach kernels, as appears from the words, "Pronounce not the name of A. I. O. under the penalty of the peach," deciphered by M. Duteil, on a papyrus in the Louvre. Here is evidently a threat, to such as reveal priestly secrets, of death by waters distilled from the peach kernel, which we know to contain prussic acid. From Egypt the knowledge of the fatal potion seems to have passed to Italy. A Roman knight in the reign of Tiberius, accused of high treason, swallowed a draught of poison, and fell dead at the feet of the senators. Unless we fall back on the theory of some sudden syncope from natural causes, nothing but prussic acid, and that fairly strong, can account for this sudden death. A further example of the use of prussic acid in Rome is the murder of Britannicus by his brother Nero. Hot water was a favorite drink in fashionable Roman circles at this time. One day, after dinner, a slave brings to Britannicus his beverage. It is too hot. Cold water is added, presumably containing the poison. Immediately on drinking, the victim lost power of speech. The breathing ceased. His mother and sister were horror-stricken. Nero, the murderer, looked coldly on, remarking that such fits often happened to him in infancy without evil result. In a minute or two the banquet proceeds. If this, again, were not sudden brain or heart disease, the cause of death must have been prussic acid.

Owing to the loss of the ancient knowledge of anatomy and physiology possessed by the Egyptian embalmers, no post-mortem was possible. In the absence of such knowledge, much importance was attached to outward signs. Doubtless many persons must have died from poison and the reason of their death remained unknown, while others, who died naturally, but whose bodies putrefied rapidly, were supposed erroneously to have died from poison. Indeed, up to the present day there lingers a belief in these outward and visible signs. When Pope Alexander VI. died, probably enough from poison, his body (according to Guicciardini) became a fearful sight, too unclean to describe here. When the Duke of Burgundy wished to raise a report that John, Dauphin of France, had been poisoned, he described the imaginary event thus:

"One evening our most redoubtable lord and nephew fell so grievously sick that he died forthwith. His lips, tongue and face were swollen. His eyes started out of his head. It was a horrible sight to see, for so look people that are poisoned."

In point of fact, these extraordinary symptoms are less likely to ensue in cases of poisoning, for, as a rule, a poisoned man is cut off while healthy, and with his tissues sound and less liable to rapid decay than if he had suffered from disease.

The use of poison is entirely opposed to the Anglo-Saxon habit of thought. To what anger the people were wrought by the detection of poisoners is shown by the execution at Smithfield, in 1542, of a young woman convicted of poisoning three households. She was boiled alive. But at about this time we find the Venetian and other Italian courts formally treating poisoning as a legitimate method of securing their ends. Especially is this the case at Venice. In the dark records of the "Council of Ten" we find the names of those who voted for and against each assassination, the reasons adduced, and the sum to be paid the agent. For example: On December 15, 1543, a Franciscan brother, John of Raguba, offered a selection of poisons, and declared himself ready to remove any objectionable person out of the way. For the first successful case he required a pension of 1500 ducats yearly, with an increase of pay for further services. The presidents, Guolando Duoda and Pietro Guiarini, placed the matter before the "Ten" on January 4, 1544, and, on a division (ten to five), it was resolved to accept so patriotic an offer, and to experiment first on the Emperor Maximilian. The bond laid before the "Ten" contained a regular tariff of charges, ranging from 500 ducats for the grand sultan to 100 for the pope and 50 for the Duke of Mantua. The council appears to have quietly arranged the deaths of many public men. In successful cases we find the single grim marginal note, "factum," accomplished.

The drugs used by the Venetian poisoners are not certainly known. Baptista Porta, writing in 1589, includes a vast mass of information on poisons in the cookery section of his book on "Natural Magic"! It seems to be an open question whether cooks most needed a knowledge of poisons or poisoners a knowledge of cookery. We have a more certain knowledge of the methods of the Italian schools of the sixteenth and seventeenth centuries. The iniquitous Toffana made solutions of white arsenic, of various strengths, and sold them as "Acquetta di Napoli." She is said to have poisoned more than 600 persons, including two popes, Pius III. and Clement XIV. The composition of the Acquetta di Napoli was for a long time a secret, shared, strange irony of fate, by the reigning pope and by the Emperor Charles VI. The "Acquetta di Perugia" was another choice preparation. Its manufacture is thus described: "A hog was killed and cut into joints, which were rubbed with white arsenic. The juice which dripped from them was preserved and accounted far more deadly than the ordinary arsenical

solution." In view of recent work on bacteriology, this seems extremely likely. Secchi has actually succeeded in preparing highly poisonous organic compounds of arsenic by allowing animal matters to putrefy in contact with white arsenic; the liquids swarm with bacteria. The talented lady who dispensed this brew was arrested in 1709, but availing herself of the protection of the Church, continued to sell her wares unmolested for nearly twenty years longer. She taught her art to Hieronyma Spara, who formed an association of young married women, in the papal reign of Alexander VII., for criminal purposes. They were detected and convicted on their own confession. The persuasive measures employed to secure confession have not been officially recorded! It would almost seem as if "suttee" might well have been introduced into Italy three hundred years ago.

In the letters of Mme. de Sévigné and in Voltaire's "Siècle de Louis XIV," are written accounts of another school of poisoners, that of St. Croix and Mme. de Brinvilliers, the pupils of Keli. The lady appears to have been as cold blooded as Toffana. She made experiments on the patients in the Hôtel Dieu, in order to test the strength of her preparations, and invented "les poudres de succession," an arsenical preparation. She poisoned her father, brothers, sister and others of her family. St. Croix was killed by the fumes of a preparation on which he was engaged. Mme. de Brinvilliers was detected, but sought safety in a convent. She was enticed thence by a police officer disguised as an abbé. She was afterward beheaded and burnt near Nôtre Dame.

Since the times of Toffana, Keli and St. Croix such progress has been made in pathology and analytical chemistry as to render a repetition of these crimes impossible, by making detection certain. Arsenic, the darling of the mediæval poisoners, is rendered worse than useless by the delicate tests which have been placed in the hands of the expert. Chemical research has indeed placed new and subtle weapons in the hands of the poisoner, but it has rendered his detection inevitable.—Pharmaceutical Journal.

AN INTERESTING CASE OF GASTROTOMY.

THE Journal of the American Medical Association, Chicago, publishes in the issue of March 5, 1898, a most curious and interesting article entitled "Gastrotomy for the Removal of Foreign Bodies in the Stomach, with a Report of the Case and a Table of Reported Cases Operated on up to the Present Time," by A. H. Meisenbach, M.D. Through the courtesy of this journal we are enabled to present an engraving of the objects removed from the stomach of "Signor Ranana," and our article is a condensation of Dr. Meisenbach's learned paper. Although gastrotomy for the removal of foreign bodies was performed as early as 1602, it is remarkable to note that from 1602 to 1887, a period of 285 years, only thirty-five cases have been reported as operated upon. Many cases of foreign bodies in the stomach no doubt were not operated upon, and perhaps some have been operated upon of which no report has been made. From 1887 to date, twenty-two cases have been reported. Gastrotomy, in the preantiseptic and aseptic period, was a comparatively safe operation, only five out of the thirty-five cases operated on prior to 1887 having proved fatal. The patients were usually either lunatics or fakirs who swallowed the objects for money.

The indications for the performance of gastrotomy are, 1, the presence of a body that, on account of its size or form, cannot pass through the intestines; 2, the presence of urgent symptoms in the patient.

The foreign bodies may remain in the stomach for a long time without causing serious disturbance, and in some cases their presence may not be known until discovered after death by post-mortem. When the presence of foreign bodies in the stomach can be established, the sooner they are removed the better will be the prognosis, no matter what the character of the body may be. To the cases which have already been reported, Dr. Meisenbach is able to add most valuable testimony regarding, perhaps, the most curious case on record.

The patient, Signor Ranana, termed himself "The Human Ostrich," and had followed the profession of swallowing glass, metal, etc., for a period of nine years. He presented himself to the clinic of Dr. Meisenbach, and stated that his father and mother were living and of a very nervous temperament. He was twenty-two years old and had received a very fair education, attending public high school and college. While still at school, he witnessed in March, 1888, an exhibition by a professional glass eater. He paid $10 to learn the feat, and after a few days he found he could perform the operation nicely. First he gave private exhibitions and took great interest in swallowing other objects, as nails and sword swallowing. In 1894 he joined a specialty company, and since that time he has been continually giving private and public exhibitions, at least one or two a week. He does not remember the quantity of things swallowed. In the early part of March, 1897, he started out on a trip, and, on account of scarcity of funds, was obliged to give as many as from six to twelve exhibitions daily in saloons and elsewhere, but he did not swallow much at a time, only a bit or two of glass, four or five nails, screws and a few fence staples. He always carried a supply of objects, so as to be able to give an exhibition of swallowing at any time. In his repertoire were pearl top lamp chimneys, two, four, six and eight penny nails, wire fence nails, barbed wire fence staples and thirty-two and thirty-eight caliber cartridges. He never swallowed tacks.

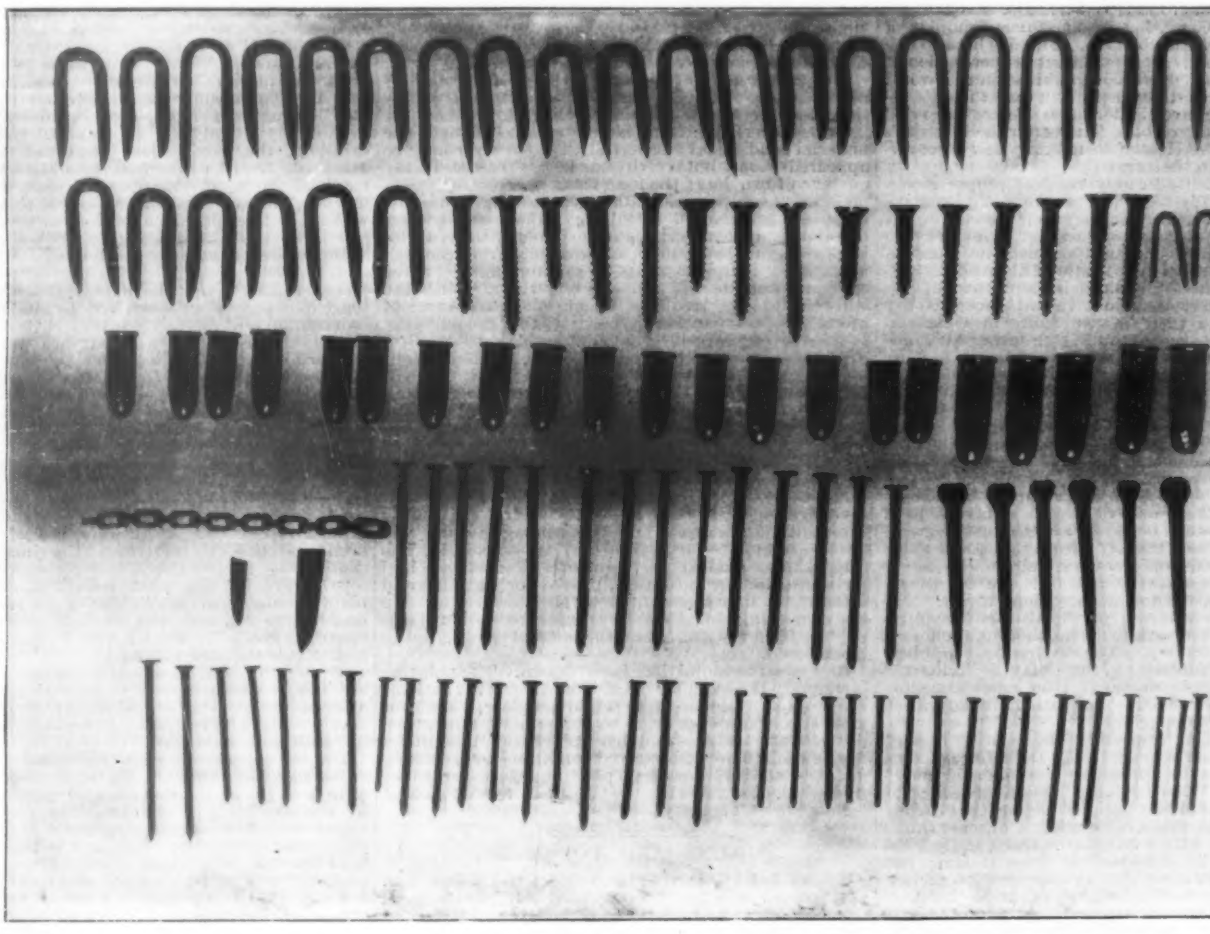
The patient stated that, up to 1897, he never had any trouble; but on March 15 he gave a number of exhibitions, and on March 16 he began to feel ill. Dr. Meisenbach examined the patient and found he weighed 153 pounds; his color was pale, his gums spongy, and his breath very foul; his pulse 76, temperature 98° and respiration 23. The patient was stripped to the waist. An inspection in both an upright and a recumbent position revealed nothing abnormal. Dr. Meisenbach was able to determine by a physical examination the presence of foreign bodies in the stomach. The patient was admitted to the Rebekah Hospital, for observation and preparation for the operation. The question whether the foreign bodies were located in the stomach or elsewhere was a very important one from an operative and prognostic standpoint. Being firmly convinced by the diagnosis that the foreign bodies were located in the stomach, other corroborative testimony was hardly necessary. His diagnosis was concurred in by other medical men.

On April 5 the stomach was inflated with air, so as to more clearly outline its lower part. It was decided to demonstrate, if possible, the mass of foreign material by the use of X rays. The experiments were made April 2. The apparatus used was Thomson's high tension coil, 6-inch spark. The apparatus worked admirably and the fluoroscope was first used. By it the mass could be outlined as a dark spot, about four or five inches in diameter. A radiograph was then taken, but the plates when developed did not give as good a shadowgraph as was desired. Several exposures were made. On developing the plates it was found that the plate of the first exposure was the best, the one exposed one hour was the finest of all. The total time during which the patient was exposed to the X rays at various sittings was five hours. On April 2, at 3 P. M., the operation of gastrotomy was performed by Dr. Meisenbach, assisted by Drs. Born, Dorsey and others. The stomach was washed out with Pasteurine solution. The anæsthetic was chloroform.

The incision from the xiphoid to umbilicus was made in the median line and anterior wall of the stomach presented in the depths of the wound. It was noticed that the stomach was dragged down considerably. Dr. Meisenbach introduced his hand into the abdominal cavity, and could feel the mass situated behind the umbilicus and to the right of the spinal column. Pulling slightly on the anterior wall, he was able to draw the stomach out of the abdominal wound to such an extent as to bring the mass into the bottom of the area of the wound. Grasping the stomach wall with two short bullet forceps, he made an incision between the forceps in the "cavum" with a knife, the forceps being held by an assistant. Previous to opening the stomach, sterilized gauze was packed around it and into the wound, effectually shutting off the abdominal cavity. The part of the stomach that was extra abdominal was lifted up by the assistants, and was also protected by sterilized gauze. The opening into the stomach was two inches in length. He introduced a pair of Bergmann calculus forceps and delivered the articles that were on top in the pile of hardware. He continued this operation with the forceps until he felt that its further use might jab the sharp articles into the stomach wall. He then enlarged the stomach incision, and introduced his hand. With his left hand he scooped out the remaining articles and worked very carefully, so as not to injure the stomach walls and also not to cut his fingers on the sharp points of the nails, staples and the broken pieces of glass.

The objects were all clean. The iron was blued and smoothed. The pieces of glass and copper of their natural color and bright. During the operation of the removal of the objects, there was a continued secretion into the stomach taking place, so that it was necessary every now and then to mop this out by means of gauze sponges. The color of the secretion was greenish black. Dr. Meisenbach then examined the stomach carefully to see that everything had been removed. The interior of the stomach was then irrigated with sterilized water, a small quantity being poured in and mopped out again with gauze sponges. The stomach wound was closed by three rows of sutures. The stomach was carefully wiped off with gauze sponges, as was also the abdominal wound. The abdominal wound was closed by antiseptic sutures, iodoform collodion was applied over the abdominal suture and a cotton pad and a bandage applied. The time occupied in the operation was one hour.

The list of articles removed from the stomach and shown in our engraving is as follows: Twenty-five staples for barbed fence wire; fifteen 1½-inch screws; six 2-inch horseshoe nails; sixteen 2-inch wire nails;



OBJECTS REMOVED FROM THE STOMACH OF SIG. RANANA BY A. H. MEISENBACH, M.D., AT THE REBEKAH HOSPITAL, ST. LOUIS, APRIL 7, 1897.

thirty 1½-inch wire nails; sixteen 32-caliber cartridges; five 38-caliber cartridges; two pocket knife blades (broken); two inches of brass wash stand chain and two small staples; total, 119 pieces. Eight cartridges passed after operation. There was also one ounce of comminuted glass (electric light globe); making the total number of objects 127; total weight, one pound.

Dr. Meisenbach then gives a detailed account of the progress of the patient after the operation. He continued to improve rapidly. By May 1 the wound was fast closing up by granulation. The patient on April 11 was found to be suffering with pneumonia. With the general improvement the lung also became cleared up, so that by May 1 all symptoms of consolidation had passed off. Dr. Meisenbach makes some remarks regarding the interesting features of the case, in which he states that there was practically no shock at all. Pneumonia was a curious complication and it is not known definitely what was the cause of it. Dr. Meisenbach suggests that the X rays may have been the cause of pneumonia. The doctor also believes that the non-union of the wounds was also owing to the X rays. He states that the case of Signor Ranana was the only one in which the X rays have been used in gastrotomy, and this case is also the first reported in this country of pneumonia following the application of the X rays. We cannot give the interesting table giving minute particulars of the various operations of gastrotomy, but the following is a summary of the articles found and removed from the stomach by operation. Forks in thirteen cases; hairballs in seven; knives in six; plates with teeth in six; spoons in five; pieces of wood in four; pieces of metal wire in four; nails in four; buttons in three; needles in three; tooth brushes in two; safety pins in two; peach stones in two; and screws, bar of lead, piece of earthenware, tracheal catheter, metal probang, part of sword blade, clay pipe stem, razor, pocket knives, hair pins, pieces of glass, keys, window latch, piece of graphite, and tacks, in one case each.

HIGH JUMPING.

EVEN among the most enthusiastic bicyclists and scorchers we do not think that there are any to say a word against the open air athletic exercises that we have been witnessing for some years past. There is today not a lyceum, not a college, not an association that has not its athletic club, with badges more or less odd, and the utility of which, from the viewpoint of the muscular development of youth, is undeniable. The special organs of bicycling themselves are obliged to follow the movement, and some of them, founded for the express purpose of singing the praises of Queen Bicycle and Empress Automobile, are now devoting more than half their space to athletic and out of door exercises.

We have in nowise the intention of passing in review the various exercises converted into sport by fashion. It would be a case of citing Horace's "miscuit utile dulci." But it seems that for the last two or three months the predilection has been for jumping; not among those who are directly concerned with the movement mentioned above, and who practice all bodily exercises, but among the outsiders who hold themselves somewhat aloof and know nothing about the present status of athletics except what is offered to them in circuses, which themselves are forced to march to the music of the times. Is it not true that in the glorious epoch of the "noblest conquest" circuses were the kingdoms of horses? Then came the bicyclists, and how many varieties of them! At present we have athletes, wrestlers, horsemen again (they will never be dethroned), learned animals and jumpers. And if attention is directed for the moment to the latter, it is on account of that wonderful artist John Higgins, one of the latest discoveries of M. Houcke, the manager of the New Circus. Higgins is certainly not an ordinary man, and we believe that such a leaper has rarely been seen. In order to find his rival it would doubtless be necessary to go back to the heroic times of ancient Greece or all-powerful Rome.

When leaping is spoken of, one imagines that this exercise is a very natural and very simple matter. To begin with, what is leaping? It is a movement, and a progressive one, in which the body suddenly leaves the ground in order to be projected forward and upward by an impulsion of the lower limbs. In leaping, there are three very distinct phases, the phase of preparation, that of suspension (ascent and descent) and that of termination, all of which are found again in the different kinds of jumping—horizontal, upward and downward.

Higgins practices especially a combination of the horizontal and upward jump, and always with the aid of dumbbells, for a reason that we shall presently state. In this way he bounds over one or two horses, eight chairs in a row with four others forming a pyramid, a man seated upon a chair placed upon a table, a hack backed up against a table, etc., the jumps varying in length from 16 to 20 feet and in height from 6 to 10. It will be said that these are ordinary exercises. They are, in fact, if a spring board be employed; but Higgins discards the use of the latter and makes all his jumps with feet placed close together. He uses a board solely to correct the inequality of the ground of the circus ring. Are these, then, feats of strength? Not altogether; but the leaper has been able to find, as before stated, assistants in dumbbells, which he employs in an intelligent manner, for the weight of the bells is changed according to the leap. It would be absurd to think (as has been written) that he takes a point of support without bearing thereupon, for we cannot well conceive of a point of support formed solely of strata of air.

Such leaps combined with the use of dumbbells, moreover, were practiced by the ancients, and quite recently M. Marey related to us the explanation given by Dumas de Montpellier, who was one of the first to endeavor to study motion in man and the animals. He claimed that when the leaper dropped his dumbbells the body became more at liberty and went further. This explanation is on a par with that of the imaginary supporting point, and is absolutely contrary to the elementary principles of mechanics, since it must not be thought that the jumper simply drops his dumbbells, for he throws them violently to the rear, and it is this reaction that carries him forward. This forward motion, which occurs at the culminating point of the elevation, permits the jumper, in addition, to perform certain curious exercises, such as extinguishing with his feet a candle placed upon the head of a man over whom he jumps, or jumping into a tank of water, simply grazing the liquid and landing at a distance of five feet beyond.

Although some may say that physical feats of strength do not demonstrate much, jumper Higgins will have rendered great services to those who, like Prof. Marey and Dr. Paul Richer and others, are devoting themselves to the study of the various motions of the body. And thus it is that Prof. Marey is soon to chrono-photograph Higgins, whom he will study scientifically and endeavor to find the relations that may exist between the length of the jumps and the velocity imparted to the mass of the dumbbells.

From a physiological point of view, Higgins is built like an ordinary individual. In street costume, one would not say that this elegant gentleman was so extraordinary a jumper, but in tights one immediately perceives the development of the muscles of his thighs and calves, and the exaggerated development of the scapular ones, which are not very conspicuous in man and in part cover the shoulder blades. Such development is due to the continual throwing of the dumbbells to the rear; and this well shows the aid afforded by these weights in jumping forward. We think that Higgins will remain as one of the most wonderful jumpers that has ever been seen, even in a circus ring.

Animals have sometimes made jumps of incredible heights. The dog, the roebuck and (who would think it?) the wild boar rank as the best jumpers. We shall some day have occasion to speak of jumping among animals, but since we are at present at the New Circus, we do not wish to leave it without speaking of another firstclass jumper that was to be seen here a few weeks ago. This was a horse named La Flèche, which was purchased in Hanover by Wulf, a German trainer. It was used as a hack, but its detestable character paralyzed its talents. Although restive, it had the reputation of being a brilliant jumper, and, after a few weeks of continuous and regular training, it succeeded in clearing a barrier six feet in height without the least difficulty (Fig. 1). Probably, if it had not been rendered somewhat stupid by repeated work every night in the necessarily inconvenient ring of a circus, it might easily have been made to jump over a still higher obstacle.

In conclusion, it appears to us to be of interest to mention a few examples of remarkable jumps. According to Youatt, a horse of which three of the legs had been cauterized was placed in a stall closed by a door six feet in height, above which there was a covering three feet square. Its own height was five and a quarter feet. This animal, upon hearing the hurrahs of some huntsmen and the barking of dogs at a great distance, jumped over the door of its stall at a single bound without receiving the least visible scratch upon any part of its body.

De Turnieu, in his Leçons de Science Hippique Française, relates the following fact: In 1792, upon a wager of 500 guineas, an Irish horse was led into Hyde Park in front of the Park Lane wall, which was 7¼ feet in height on one side and but 6½ feet on the other. The animal jumped well over the lower side, but touched slightly in the contrary direction. It appears that the horse was at liberty. There are a few other rare examples of 6½ foot walls that have been cleared. Thus a huntsman of the County of Kent, pursuing a fox upon an estate inclosed by a 6½ foot wall, jumped the latter without any difficulty. In conclusion, we may say that there is one fact certain, and that is that jumpers, whether they be men or animals, must be of irreproachable conformation as regards strength, energy and vigor and, in addition to muscular power, must have an intelligence developed and cultivated by education. In man, at least, there must be a comprehension of the act to be performed, a work of observation and appreciation, and in the animal a severe and regular training; and, finally, in both beings, a decision through which they may measure their efforts by the magnitude of the task to be accomplished.—La Nature.

FIG. 1.—LA FLECHE AND HIS RIDER JUMPING A GATE 6 FEET 6 INCHES HIGH.

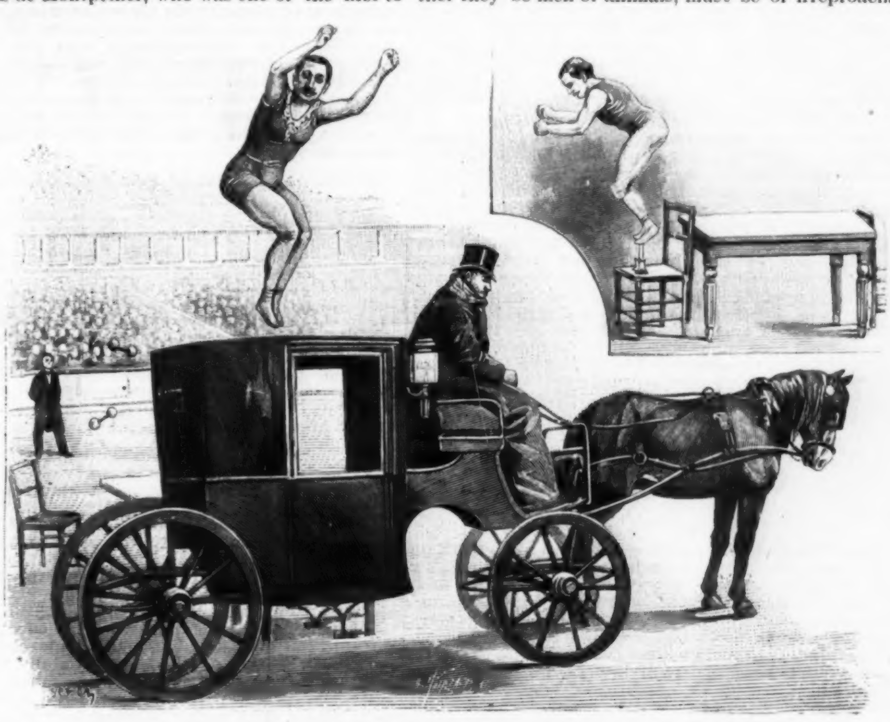


FIG. 2.—JOHN HIGGINS, OF THE NEW CIRCUS, LEAPING OVER A CARRIAGE, AND ALSO OVER CANDLES IN SUCH A WAY AS TO EXTINGUISH THEM.

To the Oregon Mining Journal W. J. Wimer, of Waldo, Or., writes: For years we were at a great expense keeping those heavy round glass points in our headlights; they are very expensive, difficult to cut and hard to keep in when once they get cracked, besides that they are always on a strain in a metal frame and break much quicker on a metal base than in a wooden sash. Two years ago I made wooden sashes for our lights, since which time we have had very little trouble with them and small expense. A glass 12 × 14 if set high at the bottom is large enough, 12 up and down and 14 wide. Common window lights are better and give a better light than those thick, heavy ones. To make the sash use coal oil box material, cut four pieces long and wide enough to fit your lamp frame inside and leave a square hole the size you want your glass; now cut out four more strips for the back of sash, drawing them in a little all around for the glass to lie on; tack these eight pieces together with wire nails, clinching them on the inside; take off the metal strips inside of the lamp frame so the sash will fit up close to the front; make two holes through the metal, one at the top and one at the bottom, insert two common wood screws into your sash to hold it; fasten the glass in the frame with tacks same as window lights. Your tacks should be outside so you can replace a glass without taking the frame out. This way one size glass will fit all the lamps in a mining camp.

ENGINEERING NOTES.

The city of Paris has been authorized by the Chamber of Deputies to borrow 165,000,000 francs for the construction of the metropolitan railway.

Warner & Swasey, of Cleveland, Ohio, are working on an extremely fine piece of machine work in the shape of a device for improving present methods of range finding in coast defense artillery work. The device makes it possible to determine the intruder's location in an instant. Prof. Albert C. Crehore and Lieut. G. O. Squire, of Fort Monroe, are the inventors of the machine, and they are supervising its construction.

A contract for American armor plate, for the Russian battleships "Peresvet" and "Olysibia," of 12,840 tons each, has been awarded to the Carnegie Company, at $500 per ton, says Engineering News. Bids for this armor were received from leading English, French and German firms, as follows: Vickers & Brown plates, $583.96 and $569.38 per ton, respectively; St. Chamond, $490 to $569, according to thickness; Creusot, $478.64 to $569; Chatillon, $486 to $563.50; Krupp, $562.52 for all sizes; Dillingen, $559.30; and Austria offered Wilkowitz plates for $452.50 for all sizes. The original bid of the Bethlehem and Carnegie companies was $530.45 for all sizes; or a little less than the $533.12 obtained by the Carnegie Company for its previous Russian contract. Russia rejected all the bids, and then made a bargain with the Carnegie Company for $500 per ton for Harvey supercarbonized plates.

An automotor van is now employed in carrying the parcel mail between London and Redhill. It is driven by steam, the engines for which were taken from a steam launch, and they have, so far, proved their suitability for the work to which they have been applied, for the motor car underwent most successfully all the tests to which it was subjected. The van is somewhat smaller than the ordinary two-horse cart and weighs about a ton and a half altogether. The steam is raised by liquid fuel, and it is said there is a total absence of either smoke or smell. The capacity of the engine is something like 20 horse power, but only about half of this power is required except in running up hill. Even with 10 horse power the van is able to run at a much higher speed than the regulation 10 miles an hour. The cost of running will not exceed twopence per mile, and we may regard this innovation as certain to be followed by other automotors embodying still greater improvements.

The coal trade on the Great Lakes is treated at length in the late report of special agent Mr. George G. Tunnell on the commerce of these lakes, says Engineering News. In comparison with rail transportation, lake carriage means cheap coal. During the greater part of the season of 1896, coal was carried from Buffalo to Duluth and Superior, a distance of 997 miles, for 20 cents per ton. This is due to the fact that coal forms about three-fourths of the westbound cargo for the vessels bringing ore, grain, flour and lumber East. During 1896 the ports of Lake Erie and Ontario shipped about 9,000,000 tons of coal, and the growth in this trade has been enormous. For example, Buffalo shipped 439,720 tons westward in 1875 and 1,448,086 tons in 1885; in 1895 this port shipped 2,617,268 tons. The shipments from Cleveland, O., rose from 1,433,035 tons in 1887 to 3,863,645 tons in 1896. This growth in traffic has been accompanied by a wonderful development in the facilities for loading and unloading vessels. As an example of work done by car dumping machines, a vessel was recently loaded at Cleveland, O., with 5,176 tons of coal in ten and one-half hours, at a total cost of $13, or one-fourth cent per ton of coal.

Rapid test soundings were required in some work on a railroad line between Paris and Havre, where the cast iron viaduct of Bezons was replaced by an arch bridge alongside. The old foundations for six channel piers were removed to the bottom of the river. It was required that the river bed should be carefully leveled. After it had been dredged, the bottom was explored by means of a horizontal bar of iron about 20 feet long, which was suspended at each end from a framework uniting two flat boats in catamaran fashion. This beam was lowered close to the bottom and the boats were gradually moved along in the direction transverse to the length of the bar. When the scraper encountered no irregularity, the suspending chains hung vertically, but as soon as either end was deflected by contact with any obstruction an electric circuit was closed, which caused an alarm to be rung. The boat was stopped, and the obstruction located by means of sounding poles. In this way, small stones, down to a diameter of 4 inches, were easily located, and the bed of the river was leveled to within the amount of irregularity. This method proved rapid and successful. This is very similar, says The Engineering and Mining Journal, to a plan used in sounding the Obi and Irkutsk Rivers in Siberia, in the surveys for the Siberian Railroad.

The Chinese railway system, says United States Consul John Goodnow, of Shanghai, is made up of two lines aggregating 293 miles in length. One is the Tientsin-Pekin line, 79·7 miles long; the other is the Tientsin-Chung-hou-so line, 214 miles long. On the first there is one passenger train daily each way and five mixed trains running over parts of the line. The operatives are practically all Chinamen, and no foreigner can compete with them. The highest paid man is the telegraph operator, at $17.80 gold per month; engine drivers receive $8.90 to $13.38 gold per month; brakemen, section hands and laborers receive $2.68 to $4.46 gold per month. The fare on the Tientsin-Pekin line is approximately 1·55 cents gold per mile; on the other road it is 1·10 cents gold. A railway from Shanghai to Woosung, 14 miles, is now being built by the Chinese themselves; the grading is about finished. The comprehensive plan of Sheng, director general of the Imperial Chinese railway administration, calls for a trunk line, 1,500 miles long, from Pekin to Canton; a line from Shanghai up the Yangtie Valley, 2,500 miles; and a line west from Canton, 1,500 miles. But these lines are all "in the air." They will only be built if money can be borrowed for them outside of China. Sheng also proposes to couple with these railway loans one of $80,000,000 to pay the Japanese indemnity. There is thus no market for American labor in China unless American capitalists first invest largely.

ELECTRICAL NOTES.

The German post office, which proposes to lay telegraph lines in German Southwest Africa, and to connect them with the Cape lines, gave notice of this intention to the British Foreign Office some months ago, but received no answer; and a second inquiry, made at the beginning of December, has also not been replied to. A bill on the subject is, however, to be laid before the Reichstag. The anti-British papers in Berlin are urging the government to connect the lines with those of the Portuguese colony of Mossamedes.

The application of electricity to a form of riveting machine is described in a recent issue of L'Eclairage Electrique. In it electromagnets are employed as clamps and hold the work together as well as the machine in proper position. The plunger which strikes the rivet moves in an electromagnet and is actuated by a powerful current. Numerous forms of this machine have been devised, adapted for different varieties of work, and it forms a good example of the constantly increasing use that is being made of electrical appliances in modern machine shop practice.

In view of the recent severe weather, the following hint by Mr. W. Fowden, in The Electrical Engineer, of New York, may be found interesting, even if it comes too late to be of use this time. The lamp trimmer is provided with a number of thin sheets of cardboard having holes punched in them of the same size as the upper carbon. These are slipped over the upper carbon of the lamp when a sleet storm is anticipated, and act as a shed for the water. Mr. Fowden states that at his station in Camden, N. J., much trouble was formerly experienced through lamps freezing, but since the adoption of this simple device such an event rarely occurs.

A 108 mile electric transmission plant is under consideration in Southern California. The undertaking involves the erection of a dam across the Kern River, in Kern County, Cal., and the construction of a line to convey the high tension current to Los Angeles. The Kern River drains an area of some 2,345 square miles, and a total of about 12,000 horse power can be obtained. A pressure of 30,000 volts is proposed for transmission. While this is exceptionally high, the dry atmosphere and infrequent rainfalls warrant its adoption. The dam will form a storage reservoir, with a volume of about 13,721,400,000 gallons, or the equivalent of 42,000 acre feet. Should the project be carried out, it would be by far the longest electric power transmission line in the world.

The Electrical World, of New York, states that a petition to the Commissioner of Patents has been prepared and is being circulated among the prominent "electrical attorneys," asking him to instruct the examiners of patents in the electrical divisions to work out a logical and symmetrical set of signs, to be published in an official order. The need for such a conventional set of symbols in patent diagrams is—as yet, at any rate—hardly felt by electrical engineers in this country, the diagrams being, as a rule, the part of the specification most readily intelligible to them. Perhaps, however, to the lawyers and patent agents who are familiar with legal phraseology and commaless sentences, the comprehension of the diagrams may present greater difficulties.

The fact that the paramagnetic metals—iron, cobalt and nickel—have a different electric resistance, according as the specimens examined are magnetized or not, was first observed by Lord Kelvin. The variation is an increase when the resistance is measured parallel to the lines of magnetic force, a decrease when perpendicular to them. J. C. Beattie describes some experiments which had for their object the investigation of the manner in which the resistance varies in films of cobalt, nickel and iron transversely magnetized. Kundt having shown that in such films the Hall effect is proportional to the magnetization, some simple relation might be expected. The method employed by the author consisted in measuring for any one film the Hall effect and the resistance perpendicular to the lines of magnetic forces, and seeing whether any simple relation existed between them. The films were deposited on platinized glass by electrolysis. It was found that the variation of resistance due to magnetization was greatest in nickel and cobalt, and least in iron. The lowest field strength at which the variation can be observed is 1,000 C.G.S. units for nickel, 2,000 for cobalt and 6,000 for iron. In cobalt films the variation of resistance is proportional to the square of the Hall effect, and hence also to the square of the magnetic field. In nickel the variation of resistance differs very considerably according to the specimen used, and after first use it usually is higher than the square of the magnetization. In iron it is lower.—Beattie, Phil. Mag., March, 1898.

Some time ago Koller found that with certain liquids the thinnest films had the highest resistance. This somewhat resembles Wiedemann's discovery of the extreme resistance of the dark cathode space, and the observation that under certain conditions short spark gaps have a higher resistance than long ones. G. B. Bryan has studied this remarkable effect in detail, with all kinds of precautions. Koller himself obtained the films by placing a gilt brass plate on the bottom of a vessel and another plate upon it separated from the first by sheets of glass of various thicknesses, and filling the vessel with water, benzol, turpentine and other liquids. Bryan used a screw instead of glass separators; but, in the first apparatus used, an error in adjustment was introduced by the fact that the upper plate rotated with the screw and was not always parallel with itself. He therefore devised an improved apparatus in which the upper plate did not rotate, and the plates could easily be removed to be cleaned, and could be replaced without interfering with the adjustment. The plates were scraped up to a good surface plate, and alternating currents of 200 alternations per second were used. With this apparatus it was found that for dilute solutions, alcohol and aniline, the conductivity is the same for all thicknesses within the limits of the experiments. In other words, these liquid films obey Ohm's law. Koller's contrary results are probably accounted for by impurities, by unevenness of his plates and by polarization due to the continuous currents he used.—Bryan, Phil. Mag., March, 1898.

SELECTED FORMULÆ.

Unclean Lenses.—If in either objective or eyepiece the lenses are not clean, the definition may be seriously reduced or destroyed. Finger marks upon the front lens of objective, or upon eyepiece lenses, dust which in time may settle upon rear lens of objective or on eye lens, film which forms upon one or the other lens, due occasionally to the fact that glass is hygroscopic, but generally to the exhalation from the interior finish of the mountings, and, finally, in immersion objectives, because the front lens is not properly cleaned, or oil has leaked onto its rear surface, or air bubbles have formed in the oil between the cover glass and front lens. The latter two causes may totally destroy all definition, no matter how excellent the objective is or may have been.

Remedy.—Keep all lenses scrupulously clean. For cleaning, use well washed linen (an old handkerchief) or Japanese lens paper.

Eyepieces.—To find impurities, revolve the eyepieces during the observation; breathe upon the lenses, and wipe gently with a circular motion and blow off any particles which may adhere.

Dry Objectives.—Clean front lens as above. To examine rear and interior lenses use a two-inch magnifier, looking through the rear. Remove dust from rear lens with a camel's hair brush.

Oil Immersion Objectives.—Invariably clean front lens after use with moistened linen or paper, and wipe dry.

In applying oil examine the front of objective with a magnifier, and if there are any air bubbles, remove with a pointed quill, or remove oil entirely and apply a fresh quantity.—Jour. Applied Micros.

Belt Dressings.—The saving of power, belt leather, etc., that follows the use of a good belt dressing on drive or race belts of spinning mules and other machinery is of considerable consequence to any manufacturer, says The Boston Commercial Bulletin. In order to detect a good from a poor belt dressing, so far as frictional properties are concerned, an apparatus can be used with benefit. It consists of the upright stand in which a pulley is arranged to turn in a bearing. A piece of 2 or 3 inch belting should be secured to the floor and the other end to a lever. One end of the lever is studded and the other end held down by a bolt. The pulley may be turned from the main shaft of the mill by putting another pulley on the shaft with the second pulley, and belting the former to a pulley on the mill shaft. The dressing compound to be tested can be applied between the pulley and the belting and the affair started running. The proportion of increased friction obtained by using the belt dressing may be figured out according to the tables in any engineer's handbook, using as a basis the proportion of additional friction which has been brought to bear upon the belt as a result of drawing down the lever by means of a bolt.

Converting and Sweetening Rancid Butter.—One hundred pounds of butter is mixed with about 30 gallons of hot water, containing ½ pound of bicarbonate of soda and 25 pounds of fine granular animal charcoal, free from dust, and the mixture is churned together for half an hour or so. The butter is then separated; after standing, warmed and strained through a linen cloth, then resalted, colored and worked up with one-half its weight of fresh butter. 2. To Sweeten Rancid Butter.—Rancid butter may be restored, or at all events greatly improved, by melting it with some freshly burnt and coarsely powdered animal charcoal (which has been thoroughly freed from dust by sifting) in a water bath, and then straining it through clean flannel. A better and less troublesome method is to well wash the butter with some good new milk, and next with cold spring water. Butyric acid, on the presence of which rancidity depends, is freely soluble in fresh milk.

Acid-resisting Aluminum.—While aluminum is known to be easily attacked by alkalies, even strong acids do not injure it in the least. It behaves almost as indifferently as platinum. Aluminum may be left to the strongest nitric acid for days without any effect being visible. This property makes aluminum very valuable for certain purposes. The writer uses aluminum hooks to take out photographic plates from the acid trays. No other material is capable of withstanding the action of the rather strong nitric acid used for acidifying the plates, for any length of time. Even hard rubber hooks were corroded in a comparatively short time. The aluminum hooks were found to be invaluable and have the advantage of infrangibility over glass hooks. For acid funnels aluminum may also be employed to advantage.—Technische Mittheilungen.

A New Ink.—

Tannic acid	1	ounce.
Pyrogallic acid	⅛	drachm.
Lactate of iron	1	ounce.
Sulphate of iron	1	"
Pyoktannin	⅛	drachm.
Tartaric acid	1	ounce.
Warm water	6	pints.

Shake well to dissolve. Set aside for a few days, shaking occasionally. Strain through cotton wool, and add 1½ ounces of fresh mucilage. This ink writes a deep black, and gives good copies, it is said.—Ch. and Dr.

Annealing Cast Iron.—To anneal cast iron, heat it in a slow charcoal fire to a dull red heat; then cover it over about 2 inches with fine charcoal; then cover with ashes. Let it lie until cold. Hard cast iron can be softened enough in this way to be filed and drilled. This process is exceedingly useful to iron founders, as by this means there will be a great saving of expense in making new patterns.

German Silver Substitute.—A substitute for German silver can be made by the use of manganese, the different metals and their proportions being as follows:

Copper	67·25 per cent.	Manganese	18·50 per cent.
Zinc	13·00 "	Aluminum	1·25 "

The color of this metal is said to be very good, resembling German silver closely. It is fully as strong as the best German silver and has superior casting qualities, which will be appreciated by foundrymen who have experienced some of the difficulties in casting German silver.

SPAIN AND THE UNITED STATES.

IT is an interesting matter at this time to consider the chances of war between Spain and the United States as viewed from an English standpoint. The London Engineer, in a recent issue, publishes a letter from a New York correspondent. In commenting upon this letter it speaks as follows:

We publish this week a most interesting letter upon the situation, from a correspondent at Washington, who goes minutely into the question of naval resources upon both sides, and points out that the command of the sea would apparently be in the hands of the United States in case hostilities occur. He observes that the question of coaling would be very important, and that Spain, after exhausting her supplies of coal in Cuba and Porto Rico, would have no nearer coaling station than the Canaries, 3,500 miles away. He is quite right. No squadron of modern war vessels could retain its usefulness without safe coaling bases, and doubtless this is one of the reasons which induced Spain to abstain from making a declaration of war against the United States some weeks ago. But as neither the writer of this letter, nor, indeed, we ourselves, can have any idea of the quantity of coal which is kept at Cuba, it is impossible to say how long the reserves would last. It must be remembered that naval actions in the present day are prompt and rapid. The forts at Alexandria were reduced in the course of a single morning, and Yalu was settled in two hours. In the letter from Washington the armored "Oquendo" and "Cardinal" cruisers are apparently forgotten, both of 7,000 tons displacement and 20 knots speed. The former is ready for sea, and the last mentioned must be close on completion. She was being rapidly pushed on more than a month ago. Six small battleships, or armored cruisers, of 20 knots speed, with a normal coal capacity of 1,200 tons, comprise a most formidable force, and if the Spaniards know how to fight and run these ships to profit instead of loss, they may do infinite mischief. Here, however, is the crux of the whole question. "U. S. A." appeals to the Anglo-Saxon stability and courage of his countrymen, and evidently thinks that the quality of the man behind the gun is of more importance than resources of coal or serried lines of armored cruisers. Here we think he is probably right, and feel inclined to sympathize too, for is he not one of ourselves?

But to be forewarned is to be forearmed. We have already in these columns emphasized the fact that Spain has no commerce to be preyed upon, while the United States has a magnificent fleet of mercantile steamers, which would be mere shell-traps for an enterprising enemy, well provided with swift armored cruisers, and having no convoy duties to undertake; also that the coasts of Spain are absolutely sealed by coast defenses of the most effective type; while the United States has a naked, defenseless coast line, 13,200 miles long, excluding the numerous bays and sounds, only scattered spots here and there being protected by guns. This is, we observe, fully realized by our correspondent. That our opinion was sound has, moreover, been abundantly proved by the feverish anxiety which the United States have displayed in their endeavor to overtake leeway as to war preparations. Only last week the War Department at Washington opened tenders for an unprecedentedly large order for shot and shell intended for the heavy gun batteries that have been erected around the coasts, and for those which are in course of construction in pursuance of the coast defense scheme which was taken in hand three years ago. This is an excellent move; but a coast line 13,200 miles long cannot be effectually fortified in a few months or even in a year or two's time, as we fear the people of the United States may find to their cost if they drive the Cuban question too hurriedly to a conclusion—always provided that Spain acts up to her old traditions. The amount of work which has actually been completed by America in this respect, in comparison with what remains to be done, is absolutely infinitesimal. With a view to illustrating what we mean, we give this week an engraving roughly showing the nature of the fortifications which have been constructed at San Francisco to protect the port. The Golden Gate is a narrow entrance, in some places only one mile across, reaching from the Pacific Ocean into the magnificent harbor within which the town is built. This has batteries of 10-inch and 12 inch rifled guns in open implacements, near the spots marked with crosses (+ +) on the north shore of the Straits; and, on the south side, in a sort of re-entering angle, sheltered by a rocky hill from direct gun fire, through the mouth of the passage, is the new battery of seven pneumatic 15-inch dynamite guns. There is little doubt that these heavy batteries of ordinary and pneumatic guns would render an excellent account of any enemy that should attempt to force an entrance through the Golden Gate with his vessels; there is also a hill behind the pneumatic gun battery, which affords a good site for the erection of the range finders by which these high angle weapons are laid, trained and elevated, and protects them from direct long range gun fire; but the hill is not high enough to preclude the possibility of an enemy's vessel with heavy armament and of good angles of gun elevation—such as are possessed by the Spanish battleships—lying off, say in the position of the Seal Rock, and shelling the pneumatic gun battery, after range has been ascertained. In point of fact, with the 11-inch guns of the "Viscaya," the vessel might lie off the coast, at the spot marked A in the engraving, and play at bombarding the town of San Francisco as long as she pleased. The guns within the Golden Gate would be powerless to interfere with the bombardment.

But if Spain thinks that by a protracted campaign she is likely to gain her point, she is woefully mistaken. Her only chance is to strike at once, and anticipate the preparations of the United States. The immense resources and undaunted spirit of the Yankees will otherwise work rapidly in their favor. Ships can be purchased, as well as guns and other munitions, and open batteries can be readily thrown up and armed, which may bid defiance to other than steady or prolonged bombardment. Then, again, as our correspondent remarks, there will be the coaling difficulty for the Spanish ships to get over. We seriously doubt, however, whether the spirit of the ancient hidalgos can be sufficiently roused among the officers and men of the Spanish navy to induce them to act promptly and with vigor. If it should be so, our advice to kinsfolk and acquaintance in the States is to keep their battleships for coast defense; but probably our admonitions may prove to be premature, and wiser counsels will prevail. Any alternative is preferable to war.

THE RED AND BLUE COLORING MATTERS OF FLOWERS.

IT is rather difficult to refer to an exact date the sober beginnings of our present knowledge regarding the chromogens or the visible coloring matters of flowers and leaves. Schubler and Decandolle endeavored to prove the existence of two essentially different series of flower colors, viz., the xanthic producing the yellow tints with their transitions into red and the cyanic producing the blue tints with their modifications, and that the colors of both series are formed from chlorophyl, the xanthic by oxidation and the cyanic by deoxidation. This view may, however, be considered as the result of mere conjectural surmise rather than that of a definite chemical investigation. The researches of Filhol, Cloez and Fremy served to elicit the distinction between the blue and red pigments which are soluble in water and many of the yellow which are of a resinous nature and dissolve only in alcohol and ether. The blue pigment (cyanin or anthocyan) with acids makes red flowers, alkalies turn it green; and hence it was concluded that the blue colors of flowers are not produced from the red by the action of alkalies. They found that blue, violet, red, brown and orange flowers have only one coloring matter, while yellow flowers have two, viz., xanthin insoluble in water and xanthein soluble in water.

According to Cloez and Fremy, all red and rose flowers have an acid cell sap, and the color of this sap would be due to a modification, under the influence of an acid, of a coloring matter (cyanin), which is found likewise, but in the state of greater purity, in blue flowers whose sap is neutral. Finally, it was recognized by Filhol that the flowers of poppy, Pelargonium, Camellia and Salvia contain a pigment which is more stable than that of most other flowers, that they contain no resin or xanthogen, and that when treated with alkalies they assume a blue or violet color without any green. Such were some of the earliest researches on this intricate and most interesting subject, and the fundamental error or defect which characterized them all was that the rose, blue and violet flowers owe their tints to one and the same substance, influenced by the reactions of the vegetable juices, this substance (cyanin) itself being a blue uncrystallizable mass soluble in water and alcohol, but insoluble in ether.

This mistake is one which, in the absence of any definite knowledge anent the differences in kind and the sources of the various tannic chromogens, might have been easily made by anyone who experimented on flower colors with alkalies and acids as his only reagents. By the employment of neutral reagents, however, such as acetates of lead and magnesium, the results are such as to afford ground for distinction between the various hues and tints. For instance, the fine green precipitate yielded by acetate of lead with the coloring matter of the rose tribe is turned red again by acetic acid, but the similar precipitate given by the blue pigment of harebell corolla is turned blue by this acid; and with acetate of magnesium and acid the effects are similar. The blue of scabious when treated with acetate of lead yields a similar green color with precipitate, but on adding acetic acid we have a red liquid and a still green precipitate, the portion lying under the acid liquid gradually turns blue, while the portion outside the liquid, though still bathed therewith, remains green.

This interesting experiment seems to clearly suggest a radical difference in the composition or constitution of the normal red and blue pigments of flowers, but likewise proves the fallacy of the early view that "rose, blue and violet flowers owe their tints to one and the same substance influenced by the reactions of the vegetable juices." Similar experiments even seem to show that certain distinctively red flowers, such as camellia, owe their tint to a substance which is not the same as that of other red flowers, such as rose; but in this case there is more than a suspicion that the real and original color of the former kind is blue and not red, and that artificial means could practically effect the change. Even acetate of lead when used alone to react on various red coloring matters of vegetable origin produces results which argue an essential diversity therein. Thus, with genuine red wine it yields a grayish blue or greenish color, with the coloring matter of bilberries it gives a blue precipitate, with that of mallow or elderberries a green, and with that of phytolacca berries a red-violet precipitate.

V. Vogel, experimenting later, found that, by using a concentrated solution of sulphate of copper, the color of new or old red wines was decolorized, although the fresh pellicle of the grape itself is colored violet by this reagent, as is also the extract of cherry juice; while that of bilberry remained unchanged. By the action of subacetate of lead, bilberry juice is completely decolorized, while that of cherry is not decolorized in the presence of alcohol or of red wine. The spectroscope has also been employed to distinguish between these diverse pigments, but its revelations need not be referred to here, especially as I am disposed to consider them to be not so very valuable, owing to the extreme difficulty of isolating completely the different coloring matters.

A decided advance was made toward a veritable chemical comprehension of the subject when Morren declared that the red and blue coloring matters are not formed from chlorophyl, and when Marquart observed that cyanin appeared by its characters and its little stability to approach the paracarthamin obtained by the action of sodium amalgam on quercitrin and quercetin, a discovery that immediately originated a crop of surmises, the ground whereof was that paracarthamin, similarly as cyanin, was also turned green by weak alkalies and by acetate of lead. Thus, for example, Stein, in a short and pleasant paper to the Jahrb. f. praktische Chemie for 1863, distinctly avers that in most red flowers which he examined the red coloring matter appears to be paracarthamin, and this also is the same body which is found in blue flowers; the blue pigment is none other than the saline (calcium) compound of the red matter.

Nachtrag, too, in a note on the "Natural Occurrence of Paracarthamin," concludes, from the behavior of the red bark of dogwood (Cornus sanguinea) toward alcoholic potash solution agreeing with that of the pigments of dahlia toward the same reagent, that it likewise contains paracarthamin, and he adds, "the red that can be artificially produced from plant yellow appears, therefore, to be repeatedly present ready formed in the vegetable kingdom." A certain weight of probability was imparted to these views by the fact alluded to by Stein, viz., that quercetin had previously been shown by Rochleder to exist in the flowers of the horse chestnut, and by the circumstance that in the flowers of Aesculus pavia the origin of the red pigment from the yellow can be clearly followed, as this flower when it comes forth from the bud is yellow and only by little and little turns red. If this be really the modus operandi as existing in nature, it would seem to follow that the bright pigments are really reduction products and not oxidation products—a consequence which is not usually met with in analogous cases in other departments of biology.

It is now pretty clearly ascertained that the yellow rutin or quercetin present in flowers does not, on account of the acid sap, impart a yellow color thereto in the living condition at least, and that the tannic chromogen of the red flowers is really a development product of this or other intermediate tannoid glucoside. Moreover, it is a fact that certain tannic acids do yield on reduction with HCl and sodium amalgam a red substance with reactions toward acetate of lead and alkalies similar to those of paracarthamin, but which nevertheless is certainly not the same as the latter body, although these same tannic acids appear to minister all the while as chromogens to the production of extremely vivid and brilliant scarlet and pure blue flower coloring matters.

The seemingly intimate relationship between paracarthamin and the red and blue pigments having thus by more explicit researches been dissolved, it became necessary for chemists to search for some other body which could possibly be isolated in sufficient purity so as to yield the mysterious green reaction with alkalies and acetate of lead. Everybody who has commenced the study of this subject is both pleased, puzzled and surprised by this reaction. There is a peculiarly vivid emerald-green brilliancy about it which is almost unmatchable. I have frequently prepared paracarthamin from rutin and quercetin extracted from plants, but the reactions thereof are incomparable with those yielded by the nature-formed cyanin, whether in petal or leaf. According to Wiesner, the color of the lead salt ought to be really blue, the actual green being caused by an intermixture of tannin in the solution; but experiments with carefully purified tannin show that the color is actually a dark bluish-green. However, to resume, it would appear that the researches of certain micro-chemists, such as Nägeli, Wiesner, etc., revealed for the first time the important fact that certain astringent matters were found in parts of plants which become red or blue, nay even the actual coloring matters seemed to spring up as it were grasped into the very substance of the tannin itself. It was natural, therefore, that Wigand should point out that the chromogen of anthocyan might be regarded as perhaps not tannin, but some modification thereof, which he denoted as cyanogen, "the transformation depending on a process of oxidation." This extremely valuable declaration was, however, in a most marked manner left unnoticed in later works, until Lindt detected the relationship anew, and subjoined the conjecture that the production of the red pigment might depend on phloroglucin—a decomposition product of tannin, similarly as the action of vanillin on this phenol takes place, an action which results from the combination of two molecules phenol with one molecule aldehyde with elimination of water and production of a red resinous body.

Waage, however, in 1890 recognized the fact that the presence of phloroglucin in a plant was a by no means absolute requirement for the coming forth of a soluble red pigment (anthocyan), since, for instance, many Chenopodiaceae are tinged strongly red, though no phloroglucin can be detected therein. It might possibly, of course, happen that on the production of anthocyan a consumption of phloroglucin took place, or perhaps it required a longer time to form in the light than the red matter which was suddenly created thereby in a colorless tissue, and hence in either case it would not be detected; but then again it may be objected that the metabolism would be so much increased by the action of light that even a wholesale formation or substitution of phloroglucin in the briefest time would be accounted for. Thereupon Waage performed an experiment forthwith on the seeds of buckwheat, which indicated the probability of some, though only a slight

consumption of phloroglucin accompanying the rapid formation of the red coloration in etiolated seedlings which are suddenly brought into the light. It was also observed that in the same cells where phloroglucin can be detected, tannin reactions also take place; but the reverse was not the case, as many cells contain tannin without phloroglucin being present therein. On the whole, Waage concluded that phloroglucin takes part in the formation of phlobaphenes, tannin reds, and, besides the tannin acid, it has a share also in the brown coloration of dead or dying autumn leaves.

Although the researches just mentioned were conducted mostly after the micro-chemical method, nevertheless their vast range and extraordinary minuteness of detail have supplied results which have proved of the utmost value to all practical students of this interesting theme. Nothing could be more suggestive than to be apprised regarding the precise distribution of phloroglucin, to know that it exists in one plant and does not exist in another, and sowise to lean gradually to the understanding that, although its function in the formation of certain red coloring matters stands pre-eminent, yet there are certain other red pigments with the origin of which it has got nothing whatever to do.

It does not require a specially delicate eye for color to see that the red of the rose is different from that of the foxglove, that of the rhododendron from that of the daisy, etc., and such being the case, it is reasonable to surmise or conclude that they have a different origin. What then does there remain for us to state or summarize with respect to the precise chemical causes which bring about the outcome of these brilliant red and blue phenomena of the vegetable kingdom? In a general way it may be admitted as established that, in dicotyledons at least, where the red color of flower or leaf verges toward bluish, as for instance in the rose and rosaceae generally, there the phloroglucin group enters into the molecule of the chromogen; where, on the other hand, the red is more scarlet, the chromogen seems to be of the nature of an acid, and the actual visible pigment is only a saline compound modified by exposure to the air and by certain substances, gums, mucilages which accompany it and even possibly give origin to it.

Both forms of tannic chromogen arise from a carbohydrate which, according to its chemical component and constitution, gives origin to certain intermediate tannoid compounds which seem to form, on the one hand, phloroglucin-tannin, and on the other, protocatechuic acid tannins. The former class of tannins when oxidized or dehydrated produce the actual crimson coloration, and for this purpose they do not require to enter into combination with a base; the change seems to depend on what in chemical parlance is termed condensation, i. e., the formation of an oxide or simple ether by the elimination of H_2O between two HO groups in different molecules. It has been surmised that the action is analogous to the action of aldehydes on phenols in the presence of dehydrating agents, as Lindt had originally stated (see above), but experiments conducted with phloroglucin, various aldehydes, and HCl produced in every case a crimson resinous matter which was not turned green by alkalies and acetate of lead. This green reaction is, however, yielded by a substance which is obtained by heating the lead or zinc compound of the pure tannin of the horse chestnut, etc., with dilute HCl, filtering off the phlobaphene and shaking the red filtrate with amyl alcohol, which dissolves a red substance which is washed with cold water and dissolved in ethyl alcohol. This seems to be the most successful attempt that has yet been made in the way of producing by synthesis the anthocyan and erythrophyl of flowers and leaves; and there seems little doubt that some such process as this is brought about in nature by the concentration of the cell sap through increased transpiration, etc., from these organs.

It is as well to mention that, according to Jodin, light does not exert a photo-chemical action on tannin, although it does so on chlorophyl and carotin. Also that MM. Gautier and Girard, experimenting on the regulated oxidation of the tannins, came to the conclusion in 1877 that the red coloring matter of, e. g., wine is only one of the transitory oxidation products of the oeno-tannin contained either in the skin or pulp of the grape. Tschirch likewise has pointed out that in the cell sap the tannins are oxidized directly (or, if they are glucosides, after resolution into their constituents) to red-brown phlobaphenes, some of which are formed very slowly, while others are formed very rapidly.

The latter class, viz., the protocatechuic acid tannins, may be regarded as chromogens which evolve coloring matters not out of their own molecules by condensation and dehydration, but possess the property of forming colored salts which turn blue, red, or even green when exposed to the air. It is possible, indeed, that they contain a salifiable group (chromophor) in their chemical structure; they are more entitled to be called tannic acids than the aforesaid class are. Their most important peculiarity, however, patent to everybody, is that they can embody a true blue flower. No one has ever seen, or ever shall see, a blue rose; but a blue dahlia or even a blue daisy is quite possible. The very fact of this possibility emanating, so to speak, from a source which is distinctly acid argues a power of fixation which is something stronger than that shown on the formation of a mere "lake." It was astutely observed by Stein that decidedly blue flowers, such as corn flowers, contain a large quantity of calcium, phosphoric acid and pectin. From experiments which I have recently made, I am much disposed to conclude that the presence of a certain kind of pectin associated with certain inorganic bodies explains the production of blue from the tannic chromogen, and likewise the fact that even in an acid medium the combination between these bodies is so complete that no separation or reddening, occurs.—P. Q. Keegan in Natural Science.

It is said that as early as 1812 Baron Schilling used a cable under water for exploding mines in the Neva by means of the electric spark. For a certainty we know that Col. Pasley, in 1838, made use of that method to explode the wreck of the Royal George, in the dock at Spithead.—Uhland's Wochenschrift.

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